Gaming Media and Social Effects

Yam San Chee

Games-To-Teach or Games-To-Learn

Unlocking the Power of Digital Game-Based Learning Through Performance

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National Institute of Education
Singapore
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ISSN 2197-9685 ISSN 2197-9693 (electronic)
Gaming Media and Social Effects
ISBN 978-981-287-517-4 ISBN 978-981-287-518-1 (eBook)
DOI 10.1007/978-981-287-518-1

Library of Congress Control Number: 2015946996

Springer Singapore Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer Science+Business Media Singapore Pte Ltd. is part of Springer Science+Business Media (www.springer.com)

In loving memory of my father, Chee Keng Lim,
who gave me much.

Preface

This book represents the culmination of a decade of game-based learning research spanning the years 2005–2014. It was conducted in the context of my academic work at the National Institute of Education, Singapore. The research effort subsumes conceptualization and theoretical construction, game design and development, classroom research interventions in Singapore schools, and sustained teacher professional development to support teachers' uptake of game-based learning.

In this book, I present a critical evaluation of current approaches related to the use of digital games in education. I identify two competing paradigms: that of games-to-teach and games-to-learn. Arguing in favor of the latter, I advance the case for approaching game-based learning through the theoretical lens of performance, rooted in play and dialog, to unlock the power of digital games for twenty-first-century learning. Drawing upon my research, three concrete exemplars of game-based learning curricula are described and discussed. The challenge of advancing game-based learning in education is then addressed in the context of school reform. Finally, future prospects of and educational opportunities for game-based learning are articulated.

I believe that readers of this book will find the explication of performance theory applied to game-based learning especially useful. This work constitutes my original theorization. Readers may expect to derive four main benefits: (1) an explication of the difference between game-based-teaching and game-based learning, and why this difference is of critical importance, (2) an exposition of the theory of game-based learning as performance, (3) concrete exemplars and research outcomes relating to three game-based learning curricula that have been empirically evaluated in schools, and (4) an understanding of complex issues related to the human side of school change that must be effectively addressed to achieve successful take-up of game-based learning in schools. Related to item (3), the detailed descriptions of the educational games in Chaps. 4–6, supported by color screenshots, should prove invaluable to game designers seeking a deeper understanding of how to inflect pedagogical principles into educational game conceptualization and design.

Acknowledgments

The work reported in this book would not have been possible without generous research funding. I wish to gratefully acknowledge research grants NRF2007-IDM005-MOE-006CYS and NRF2007-IDM005-MOE-007CYS from the National Research Foundation, Singapore. These grants supported the projects related to *Legends of Alkhimia* and *Statecraft X*, respectively. Research grant OER-02/11-CYS from the Office of Education Research, National Institute of Education, Singapore, supported subsequent work focusing on teacher professional development related to the Statecraft X curriculum. Research grant R8019.735.SG01 from the Learning Sciences Lab, National Institute of Education, funded the *Escape from Centauri 7* project.

I am especially grateful to members of all the research project teams who participated and contributed to the above-named projects. Their names are listed alphabetically in last name order: Daniel Gan, Aldinny Abdul Gapar, Susan Gwee, Ahmed Hazyl Hilmy, Won Kit Ho, Mingfong Jan, Henry Kang, Judy Lai Har Lee, Andy Lim, Eric Salim Lim, Qiang Liu, Swati Mehrotra, Rahul Nath, Cher Yee Ong, Jing Chuan Ong, Ek Ming Tan, Daniel Kim Chwee Tan, Rave Tan, Yuan Tien, Ittirat Vayachut, Yik Shan Wee, and Simon Yang.

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About the Author

Yam San Chee is an associate professor in the Learning Sciences and Technologies Academic Group at the National Institute of Education, Nanyang Technological University (NTU). He obtained his B.Sc. (Econ.) Hons from the London School of Economics and Political Science, University of London, and his Ph.D. from the University of Queensland, Australia.

Professor Chee's research focuses on new media and new literacies in education, with a special emphasis on game-based learning in formal learning environments. Educational games that have been developed include *Legends of Alkhimia*, *Statecraft X*, *Space Station Leonis*, and *Escape from Centauri 7*. Prior work revolved around the design, development, and evaluation of learning environments that make use of distributed multimedia computer technologies to promote learning goals. Systems developed include *Mind Bridges*, a multimedia collaborative discussion tool; *C–VISions*, a 3D environment for collaborative virtual interactive simulations; and *Voices of Reason*, a learning environment for the development of argumentation skills.

Professor Chee is a member of the Association for Computing Machinery, the Australian Computer Society, the American Educational Research Association, the International AI in Education Society, the International Society of the Learning Sciences, the Jean Piaget Society, and the International Society for Cultural and Activity Research. He was the President of the Asia-Pacific Society for Computers in Education (APSCE) for a two-year term from January 2004.

Professor Chee was the Founding Executive Editor of APSCE's journal, research and practice in technology-enhanced learning; he relinquished the position of executive editor at the end of 2008. He is currently an associate editor of the *International Journal of Gaming and Computer-mediated Simulations*, an Advisory Board Member of the *Journal of Educational Technology & Society*, and Editorial Board Member of the *International Journal of Game-Based Learning*, the *International Journal of Mobile Learning and Organization* and the *International Journal of Web Based Communities*.

In his previous employment at the National University of Singapore (NUS), Prof. Chee was with the School of Computing where he taught course modules related to cognitive science, human–computer interaction, and the design of learning technologies. He also headed research efforts in the Learning Environments and Learning Science Lab while at NUS. In addition, Prof. Chee held the positions of Associate Director, Centre for the Development of Teaching and Learning (February 1999–December 2002) and Deputy Director, Centre for Instructional Technology (February 1999–May 2000).

Chapter 1
Introduction

1.1 Background

Interacting with schoolteachers, school administrators, and education policy makers in the course of my research on game-based learning, I am often struck by how the idea of using games to support student learning is conflated with that of using games to teach facts, concepts, and other forms of "knowledge in pieces" (diSessa 1988). This conflation may have been unsurprising in the 1980s and 1990s when multimedia children's software was the default model of educational software embraced enthusiastically by parents, instructional designers, and software development companies. These stakeholders welcomed technological advances in computer graphics and digital animation that allowed them to present school content in more attractive and engaging ways (Ito 2009). Aligned with instructional approaches that dominated during this period, and which still continue to dominate today, children's software of this era was driven by the vision of harnessing technology to provide instruction on school content. This era of children's software was itself a successor to the age of computer-assisted instruction that arose when alphanumeric, monochrome computer displays were commonplace.

Since the mid-2000s, however, we have witnessed the development and spread of increasingly sophisticated computer games realized by further technology breakthroughs in graphics processing engines and pixel-based color displays. These advances have led to establishment of the discipline of game studies that formalizes the study of game design and development as we know it today (Mäyrä 2008; Raessens and Goldstein 2005). The pertinent questions that arise are as follows: Do the kinds of digital games that comprise the focus of game studies have a place in formal education? If such games are to be pressed into the service of education, how might this take place? What types of games are most suited to the educational arena (e.g., casual, adventure, simulation), and what forms would they take (e.g., Web-based, desktop, multiplayer, wireless mobile)? What pedagogies

Y.S. Chee, *Games-To-Teach or Games-To-Learn*,
Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_1

are required to complement and support game use? How would the use of games be integrated into curricula and into life in school? While this set of questions is by no means exhaustive, they give the flavor of the kinds of issues that warrant critical consideration if the effort and expense of leveraging games for learning is not to be just another passing fetish in the history of educational technology.

In this book, I examine issues related to the above questions in a critically oriented light, taking into account the needs of education in the twenty-first century (Macdonald and Hursh 2006; Trilling and Fadel 2009), a postmodern understanding of reality and its implications for education (Doll 1993; Trueit 2012), and the onto-epistemological basis of human learning (Barad 2003, 2007).

There is currently considerable interest in the use of digital games to support learning, both in school and outside of school (e.g., Lacasa 2013; Whitton 2014). In the context of twenty-first century schooling, MacDonald and Hursh (2006) argue that computer gaming opens immense possibilities for education, regardless of whether the games are single player or massively multiplayer. Spurred by the influential writings of Prensky (2001, 2006) and Gee (2007a, b), among others, considerable effort is being expended to champion the use of games for learning and to integrate game use into mainstream education. The momentum derived from the efforts of researchers worldwide is reflected in the New Media Consortium's 2012 *Horizon Report* (Johnson et al. 2012) that forecasted a time-to-adoption horizon of two to three years for the take-up of game-based learning in education. At the time of my writing, however, evidence of widespread adoption in schools and tertiary institutions still appears to be lacking.

Published research literature on the use of games in education suggests that evidence for the efficacy of game-based learning is scant (O'Neil et al. 2005) and mixed (Iacovides et al. 2012). De Freitas (2006) reports general skepticism among learners, ICT tutors, and those with technological expertise about the efficacy of games as a learning tool. A meta-review of literature by Young et al. (2012) suggests that evidence of learning effects was found for games related to language learning, history, and physical education, but not for games in science and mathematics. A separate meta-review by Connolly et al. (2012) suggests that computer games are impactful primarily for knowledge acquisition and enhancing affective and motivational outcomes only. The cumulative evidence available and the disparity of claims asserted strongly suggest that not all is well in this field of research. Consequently, a closer examination of the state of game-based learning and a critical interrogation of the assumptions that undergird work in this field can potentially be very beneficial.

1.2 Some Early Critical Considerations

To help readers approach the field with greater critical awareness, I raise four pertinent issues for early consideration. The first issue concerns the purpose of the educational game being used. Prensky (2001, p. 145) defines game-based learning as the combination of "computer video games with a wide variety of educational content" to achieve outcomes no worse than traditional (content-centric) instruction. Educators and researchers who view games primarily as vehicles for content learning adhere to the layperson's view that the purpose of schooling is to acquire knowledge. In this light, learning is understood to be something quantitative in nature and hence assessable in terms of countable output. Thus, such people speak positively of having accomplished "more learning" when using games (de Freitas 2006). In contrast, Gee's (2007b) literacy-oriented formulation foregrounds the development of learner identity that is constructed through active learning, mastering of semiotics, and engaging in situated meaning making through role-taking in immersive game environments. This latter orientation emphasizes literacy as a lived practice and the development of enactive capacities associated with roles such as that of a chemist or citizen. From this perspective, learning takes place in the first person, not the third person. Thus, learners "learn to be" some kind of person; they do not merely "learn about" some subject content propositionally (Thomas and Brown 2007). The outcome of learning is a capacity for performance that has value in the real world. It is not merely a capacity for producing representational inscriptions of a predetermined type in a canonical form on high-stakes tests. Games-to-teach follow the tradition of multimedia computer-aided instruction and instructional machines *from* which students learn, but games-to-learn position authentic digital games as tools *with* which students learn within a broader sociocultural context.

The second pertinent issue concerns game type and complexity. Bate et al. (2014) highlight the fact that, at one extreme, a game might be constituted by simple drill and practice questions triggered by the roll of a simulated dice, while, at the other extreme, a game might be characterized by multiple participants engaging with a range of sophisticated media-rich immersive activities involving complex and intelligent feedback over an extended duration. There is clearly no reason to expect the two games to have equal efficacy with respect to the learning process and its attendant outcomes. Game type and complexity are necessarily a function of educational purpose. Importantly, games are not created equal. Serious confusions and errors arise in the published research literature from authors who overgeneralize across game instances that are more dissimilar than alike. The only feature that such dissimilar games share is their subsumption under a common abstract category that we refer to as "games."

The third pertinent issue concerns widespread adoption of unenlightened pedagogy. Authentic digital games support meaning making in highly situated contexts. They entail first-person experiential learning and embed spaces for deep reasoning and inquiry. Students need to identify, frame, and solve problems involving complex activities that, by design, simulate realistic situations requiring decision-making and follow-up actions that have pertinent in-game consequences. Such games neither contain nor focus upon deriving "right answers." There are only better or worse game play outcomes relative to user-determined goals. An informed pedagogy must support and facilitate meaning making, not merely the production of approved "right answers." Unfortunately, much of game-based learning research is taken up with enhancing student motivation for learning staid content. In stark contrast with this goal, MacDonald and Hursh (2006, p. 199), citing an online document from The Education Arcade, refer to the challenge of creating "next generation games that allow students to engage in critical problem-solving, creative expression, and rich social relationships—[games] that appeal to a broad audience." This, more pedagogically enlightened, goal contrasts sharply with the tendency of schoolteachers, school administrators, and education policy makers to emphasize knowledge acquisition and content learning that I referred to at the beginning of the previous section. There is little room, indeed little need, for pedagogical innovation if content mastery is the overriding goal.

The fourth pertinent issue concerns the widespread practice of ascribing causal attribution of learning effects solely to technology artifacts, including software such as digital games. However, Selwyn (2011) rightly, in my view, argues the importance of paying attention to the entire network of social relations that surrounds and envelopes the use of digital technologies in schools. It is vital to understand that games do not "work" or "not work" in classrooms in and of themselves. They possess no causal agency. The efficacy of games for learning depends largely upon teachers' capacity to leverage games effectively as learning tools and on students' willingness to engage in game play and other pedagogical activities—such as dialogic interactions for meaning making—so that game use in the curriculum can be rendered effective for learning. Put differently, teachers and students need to work to make pedagogically informed game-based learning curricula work. One needs, therefore, to consider the entire milieu of pedagogical, social, cultural, economic, and political relations that constitute the situated system within which digital games are inserted and brought into play if a deep understanding of educational possibilities with games and the overcoming of attendant barriers to change is to be achieved.

It behooves us, therefore, as educators in the present globalized era, to approach the field of game-based learning with greater criticality so that the field as a whole can be advanced and needful actions be taken to avoid the stagnation that has beset the domain of children's educational software (Ito 2009). In the context of twenty-first century education, students need to develop the disposition of interrogation and the habit of thinking for themselves so that they can cope with accelerating change, instability, and multiplicity so evident in a postmodern world. They must also foster the capacity to wrestle with meaning (as a verb) and learning in the present century's context of innovation and creative production (Araya and Peters 2010). It is no longer adequate to frame education in terms of the pursuit of knowledge and skills, as dictated by conventional wisdom and school practice. Consequently, in this book, I take up the challenge of clarifying the distinction between the paradigms of what I have termed "games-to-teach" and "games-to-learn" and to demonstrate why this distinction matters in education today. To advance the field, I also propose the construct of performance (Bell 2008; Schechner 2003) as a theoretical lens with which to reframe game-based learning from the perspective of twenty-first century education and to unlock the power of digital games for learning.

In Sect. 1.3, I critically review contemporary trends in the field manifested in the popular discourses of serious games and the gamification of learning. In Sect. 1.4, I expand on the current educational context to suggest why serious games and gamification fail to adequately leverage on the promise and potential that digital games hold out to education. In Sect. 1.5, I provide an overview of the remaining chapters of this book.

1.3 Contemporary Trends in Games for Learning

Both the research literature and the popular literature related to the use of games for learning speak extensively of serious games and gamification. In this section, I examine these ideas more closely.

1.3.1 Serious Games

The term "serious games" was first used by Clark Abt to refer to "games [that] have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement" (Abt 1987/1970, p. 9). Readers must be mindful that when this idea was initially conceived in the late 1960s, technology of the day took the form of teletypes, time-shared computing, and educational television. Lamenting the increased emphasis on abstract knowledge that had become reflected in educational goals and the attendant decline in student motivation, Abt felt that games could be effectively used to reunite thought that had become separated from action. Drawing upon his prior experience in the Air Force, where operations analysis and war gaming were being used for mission planning, he argues that "[p]hysically inactive thought (mistrusted by Nietzsche) and mentally inactive action (mistrusted by all sensible men) are diseases of civilized man" (p. 4). As we shall see in later chapters, such thinking, a hallmark of John Dewey's philosophy, was deeply perceptive and well ahead of his time. In a further incisive critique of educational practice in his day, he contends: "when students have tried to relate abstract thought to concrete action, adults have frequently felt their own world threatened" (p. 4).

Abt recognized that games, by virtue of their simulation of processes and social roles, offered "expanded possibilities for action in a mode that, while chiefly mental, includes the felt freedom, intuitive speed, and reactive responses of physical movements" (p. 5). From a critical perspective, however, the foregoing excerpt hints at slight equivocation between the value Abt places on thinking and on acting. He speaks of games having two main components: one that is rational and analytic and another that is emotional, creative, and dynamic. Abt associates thought with the rational and analytic and action with the emotional, creative, and dynamic. Tellingly, he attempts to harness the latter in service of the former, thereby revealing the greater value placed on thought rather than action: a valuational bias that can be traced through the history of Western philosophy since the time of Plato. Despite this partiality, Abt speaks persuasively of the importance of playing roles in games because these roles are, for him, behavioral, "working" psychological models. He argues that in playing games: "The exciting uncertainty is that of identity rather than conflict outcome [of the game]; Who am I? rather than Who will win?" (p. 7). Thus, we note that, in Abt's early framing of serious games, notions of learning in relation to role-playing, to action, and to identity are clearly present.

Unfortunately, there are multiple instances in his book of ambivalence concerning what Abt regards as truly important and distinctive about serious games. The term "serious," he writes, is used in the sense of study, relating to matters of great interest and importance, raising questions not easily solved, and having important possible consequences. The kinds of games Abt shows special interest in are planning games, games to support complex decision-making, games to train financial management and merger–acquisition analysis, and games for media managers and sales personnel in basic communication skills. Thus, while he writes positively about the ability of game players to change roles and to invent new ones, these possibilities are cast as subservient to the more important objective of augmenting the complexity of decision-making through game play. He argues, "[t]he complexity of decision-making increases proportionately with the role-player's freedom of decision at every 'move'" (p. 8). While this may be so, there is a clear bias in favor of cognitive and mental training at the expense of that which is behavioral, social, and cultural. The logical, analytic, and scientific ends are upheld. The "intuitive freedom and rewards of imaginative, artistic acts" (p. 12) are merely a means to those ends. Active situations are important only in so far as they lead to new abstract knowledge.

With respect to game use in education, Abt takes the view that "the motivational inadequacies are probably in most urgent need of repair" (pp. 15–16), at least in the USA (but also almost universally), due to the restrictiveness of school environments that also demotivate teachers. His emphasis, however, remains on how games can be used to "stimulate the child to learn new intellectual concepts" (p. 17): a goal with a clear cognitive bias. This goal is to be achieved by the "active learning" that games enable. Abt speaks optimistically of using games to achieve individualized instruction, self-directed learning, as well as differentiated instruction. He states that "[e]ven relatively simple simulation games are sufficiently rich in content to provide several different levels of learning simultaneously to students of different abilities" (p. 23). He views "games testing" as having "great potential" (p. 26) and is excited by the possibility of "[g]ames stimulating *conventional* study and [being] used to summarize the results by dramatizing the interaction of disparate elements that were studied in isolation" (p. 30, italics added). Turning to the issue of cost-effectiveness, Abt argues that although costs may be reduced when learning with games, "effectiveness must be at least equal to that obtainable with *conventional* methods" (p. 111, italics added). This repeated emphasis on the use of games in relation to conventional goals, conventional study, and conventional methods—a theme actively appropriated and mirrored by Prensky—suggests the lack of a vision of using games to transform education. Rather, games are merely to be utilized as tools for solving, and resolving, conventional challenges related to the institution of school. Seen in this light, it is perhaps less startling to find that Abt does not see games as very useful in learning the physical sciences. He argues that, in the science classroom, "the student usually simulates the activity of the scientist: he conducts experiments or develops theories and solves theoretical problems. The abstract nature of the subject matter itself is not distorted or made more abstract by this static presentation; and role-playing would be at best an artificial contrived technique" (p. 36). This statement must count as one of the most disappointing pronouncements by Abt. There is no reason why learning in the physical sciences must be reduced to static presentation unless one is totally mesmerized by the myth of scientific endeavor as a happy accident of "objective discovery." Neither is there any justifiable reason to believe that role-playing is at best an artificial, contrived technique for games related to the hard sciences. In my view, such thinking reflects directly on a lack of onto-epistemological understanding, alluded to earlier.[1]

Perhaps we can excuse Abt for his limited vision of how powerful games can be for learning, given that he is neither an educationist nor epistemologist by training. To his credit, Abt furnishes us with initial glimpses of why games offer the potential for transforming education, perhaps even revolutionizing it, through reuniting thinking and acting. Unfortunately, in my view, Abt falls victim to his times by allowing the dominant, cultural understanding of schools to domesticate and reduce the possibilities for educational games by situating game use in what was, and remains, conventional notions of schooling. Writing in the Preface to the 1987 edition of his book published by the University Press of America, Abt laments that his aspiration, originally expressed in 1970, for how games would achieve "more promising and much cheaper" (p. xv) education, with students increasingly teaching other students and making use of instructional games to overcome the shortage of good teachers, has not materialized. While there are many reasons for this, perhaps that is not of the greatest consequence given his constrained perspective of education. In this book, I shall consider how we can do better and what doing better might entail.

The serious games movement was given fresh impetus by the launch of the Serious Game Initiative by the Woodrow Wilson International Center for Scholars in 2002. It sought to encourage the development of computer-based games that address policy and management issues. Due in part to this influence, the term "serious games" has come to refer to games and simulations that can be used to train decision makers in business, government, as well as education. The targeted scope of application of such games is very wide today. The Wikipedia entry[2] for

[1]In Chap. 5, I illustrate how games can be very effectively used in learning chemistry.

[2]http://en.wikipedia.org/wiki/Serious_games.

"serious game" states that the term refers to products used by industries such as defense, education, scientific exploration, health care, emergency management, city planning, engineering, and politics. Similarly, Zyda (2005, p. 26) defines a serious game as one that "uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives." From the foregoing, it should be evident that education-centric games are only a subset of the larger serious games enterprise. The degree to which entertainment value is regarded as essential in serious games remains moot in the published literature. It is well known that playing computer games such as World of Warcraft involves substantial, sustained effort; hence, the experience of playing games can be more like "hard work." I believe that educational games should be fun to play. However, the sense of fun can arise from intrinsic satisfaction derived from personally meaningful game play rather than predominantly from some form of sensual pleasure.

Authors such as Aldrich (2009) continue to champion the cause of serious games. With its mix of populism, hype, and some measure of good sense, such writings continue to drive interest in serious games, especially in the arenas of corporate training and the learning of basic skills where adherence to predefined procedure is appropriate and highly valued. As the title of Aldrich's book suggests, however, there remains an obsessive preoccupation with the creation of "valuable content" in serious games. To be fair, Aldrich devotes a chapter to learning goals couched in terms of "learning to be, learning to do, [and] learning to know" (p. 423). However, his treatment of these ideas is lightweight and fails to do adequate justice to these important ideas. This limitation appears to stem, once again, from the fact that Aldrich is neither an educationist nor an epistemologist but a technologist. Thus, he positions (1) learning to be as students' quest to find out who they are (e.g., who are the people I tend to like?), something that is learned through participation in social networks and communities, (2) learning to do as students' quest to develop and increase their own capabilities (e.g., how can I practice in virtual environments and then transfer that to real environments?), something that is learned via educational simulations and microcosms, and (3) learning to know as students' quest to see themselves in a larger context across space and time (e.g., what is a good life?), something that is learned through books and lectures. Learning, Aldrich claims, follows a progression from simple to complex—from awareness to explicit knowledge, and then to application of new content, etc.—manifesting commitment to a prescriptive take on Bloom's taxonomy (Bloom et al. 1956), beloved of instructional designers, and a reduction of the realm of human learning to that of acquiring knowledge and skills. The preoccupation with content and discovery of "facts" is disappointing to those concerned with education, where the goals of independent thinking, knowledge creation, critical interrogation, creativity, and innovative role performance—everything antithetical to unthinking adherence to procedural routine—are highly valued.

1.3.2 Gamification

The idea of gamification has lit the popular imagination. It has been extremely well received since the publication of Karl Kapp's book *The Gamification of Learning and Instruction* in 2012. Attempting to provide readers with a quick sense of what gamification is, he cites two examples that revolve around his son. He asserts that gamification takes place when his son times himself to see how quickly he can rattle off the definitions of economic terms as a study technique. And, again, when his son sits down to learn algebra in a first-person game, that too is gamification. Games, Kapp argues in the Preface to his book, "give experiences meaning, they provide a set of boundaries within a 'safe' environment to explore, think, and 'try things out'" (Kapp 2012, p. xxi). But, do games, indeed can games, so simply and directly *give* meaning to experiences as Kapp suggests, or is meaning better conceived of in terms of making, of constructing, and of arising from interpreting a situation to render it sensible? Discerning readers will recognize in this query I have posed the tension between a constructivist orientation toward understanding human learning in contrast to an instructivist framing that Kapp implicitly adopts.[3] A perusal of Chap. 8 of his book, focusing on "Applying Gamification to Learning Domains," reveals Kapp's instructional design qualifications because he positions learning and learning domains firmly within the tenets of Bloom's taxonomy, with its emphasis on the cognitive, affective, and psychomotor domains.[4]

Kapp argues that games are ideal learning environments given their built-in permission to fail, encouragement of out-of-the-box thinking, and sense of control granted to the player. "Don't think of gamification as only the use of badges, rewards and points," (p. xxii) he intones, but focus instead on the sense of engagement, provision of immediate feedback, feeling of accomplishment, and striving against a challenge that games enable. Adapting from the definition of gamification provided on Wikipedia, Kapp proposes as an alternative: "Gamification is using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (p. 10). This definition addresses, in a nutshell, the how and why of the gamification movement. Of special note is Kapp's reference to game thinking, by which he refers to translating learning into an activity "that has elements of competition, cooperation, exploration and storytelling" (p. 11). In short, make learning akin to playing a game, enabled by the programming of game rules and the creation of appealing digital graphics. As for purpose, two key goals espoused are those of learner engagement and motivation. In this regard, we observe a narrative consistent with that of the serious games endeavor. Instead of interrogating *why* conventional instruction

[3] I take up the issues of meaning and meaning making in detail in Chap. 3.

[4] In Chap. 3, I shall explain why Bloom's taxonomy is deeply problematic for learning, as opposed to instruction.

disengages learners, the assumption is tacitly made that instruction per se and the content of instruction are inherently sound, and the weakness of this approach arises from the fact that the current generation of learners are “digital natives” who have been nurtured on a diet of games from their preschool years. Such a lack of criticality, especially in light of the needs of education in the twenty-first century, regrettably translates into ongoing efforts to solve the wrong problem. As for the goals of promoting learning and solving problems, these goals are sound on the surface. But the deeper, critical questions concern learning what (is learning to rattle off the definitions of economic terms in the shortest time possible an enlightened goal?) and solving problems with what degree of complexity and real-world relevance (e.g., solving a standard textbook problem that has been solved millions of times by students all over the world for the sake of high-stakes tests or solving a problem that contributes to enhancing the well-being of the elderly in the local community?).

What might be the relationship between serious games and gamification? Kapp argues that a serious game “is an experience designed using game mechanics and game thinking to educate individuals in a specific content domain…. When you get right down to it, the goals of both are relatively the same. Serious games and gamification are both trying to solve a problem, motivate people, and promote learning using game-based thinking and techniques” (pp. 15–16). Are the two terms synonymous then? Kapp strongly disagrees. He argues, instead, that in his book:

> [S]erious games will be considered a form of gamification because serious games are a specific sub-set of the meta-concept of gamification. Gamification encompasses the idea of adding game elements, game thinking, and game mechanics to learning *content*. The goal of gamification is to take *content* that is typically presented as a lecture or an e-learning course and add game based elements (story, challenge, feedback, rewards, etc.) and create a gamified learning opportunity either in the form of a full-fledged educational game, in the form of game-elements on top of normal tasks like running for exercise, or in the form on an engaging classroom experience wherein the learners participate in a story-based challenge to master the *content* presented. (p. 18, italics added)

The constant emphasis on learning content and repeated reference to conventional classroom experience and e-learning are unmistakable. Why is this so? Because the explicit goal of the book is to “help professionals understand how to create future learning experiences that are engaging, motivational, and lead to increased retention and application of knowledge” (p. 18). One cannot avoid a feeling of utmost disappointment given (1) the repeated underscoring of “learning content” and (2) the stress placed on knowledge retention, and application, reflecting, yet again, the strong influence of a Bloomian veil cast upon learning, derived from instructional design.

In their follow-up *Fieldbook*, Kapp et al. (2014) distinguish between two types of gamification: structural and content. In structural gamification, game elements, such as story, challenge, curiosity, character, interactivity, feedback, and freedom to fail, are applied to propel learners through content with no alteration or changes to the content. Thus, the content does not become game-like; only the structure that frames the content does. In contrast, content gamification alters the learning content by the application of game elements and game thinking. Kapp et al. argue that "[a]dding these elements makes the content more game-like but doesn't turn the content into a game. It simply provides context or activities that are used within games and *adds them* to the content being taught" (p. 55, italics added). The reader will recall Prensky's (2001) definition of game-based learning, cast as the combination of computer video games and educational content, introduced in Sect. 1.2, and it should be self-evident that Kapp, Blair, and Mesch's notion of content gamification is no different from Prensky's construal of digital game-based learning. A good example of content gamification for knowledge acquisition is furnished by Kapp et al.:

> The Knowledge Guru provides an opportunity for the learners to obtain knowledge about cell phone services by engaging them to compete to climb the mountain to provide a scroll to the guru. The gamification elements include points, story, and levels and give learners a chance to practice through repetition. (p. 58)

Is this the kind of education we need for the twenty-first century? As a game, *Knowledge Guru* is little different from *Math Blaster*® by Knowledge Adventure, Inc., which "motivates" children to engage in arithmetic drill and practice by rewarding them with access to a shooting game for a short period of time. Using games to "engage" learners in this manner is a form of behaviorist conditioning and amounts merely to sugar coating an unappealing "educational" activity. The central weakness here is that learning arithmetic and playing the game constitute two wholly independent activities. Consequently, success in playing the game is not necessarily matched by success in learning arithmetic.

A particularly "interesting" example of structural gamification can be found in a case history cited in Sheldon (2012). Teachers in a seventh-grade general mathematics class in Hawaii introduced *Knowledge Quest*, set in medieval times, by mapping game terminology to common classroom objects and tasks. In effect, lessons, homework, and assessments took place in the normal fashion, but these activities and processes were overlaid with a gaming discourse. Thus, class time was divided between "fighting monsters" (i.e., doing worksheets, homework), "completing quests" (i.e., making presentations and doing case studies), and "crafting" (i.e., maintaining an Online Math Document, doing White Board Work, etc.). At the beginning of the semester, all students chose and named their avatar. "Guilds" (i.e., student groupings) were chosen and balanced by students' mathematics skill level and interests. Each guild would choose a name and design its own shield. Students began the first day of class at Level 1, with Level 10 being the highest level they could achieve. They were awarded experience points (XPs) for all the useful tasks associated with schooling: how well they did on quizzes, completion of progress reports, and completion of homework. As they progressed up the levels, they were given "gold" that could be exchanged for pencils, markers, bottled water, chips, or 20 min of game time on a Playstation. Badges were added to students' online account pages if they performed a task well. Undertaking bonus quests earned extra points. And when students turned up for remedial tutoring, they also raked up points. Negative XPs were awarded for not closing laptops when students left the classroom. We see in the foregoing example the implementation of a scheme of rewards and punishments that merely preserve the *status quo* of schooling. This example probably illustrates gamification at its most poorly conceived. The manner in which game elements have been introduced into the learning situation is superficial and highly contrived. It might be more apt to refer to this type of gamification as *linguistic gamification*. It is gamification in name only and exists only in the form of talk.

1.4 Current Educational Context

The present age of education, about a decade and a half into the twenty-first century, has been described by Gee (2013) as "the anti-education era" because many schools have been reduced to skill-and-drill test-prep academies, driven by testing and accountability requirements. Although Gee's reference is to schools in the USA, what he asserts is broadly recognizable in schools throughout the world's developed nations. Schools have become skill-and-drill prep academies because they are enamored by content—"the body of facts, information, and formulas to which the activities of science and other knowledge-building enterprises have given rise" (Gee 2013, p. 205)—rather than the human activities and processes that give rise to long-term human knowing and understanding. Through insistent and persistent emphasis on the doctrinal "right answer," the process of schooling renders reality in black and white terms, constituted by right *or* wrong—there are no in-betweens and no shades of gray—and students become enculturated into a reductive, misrepresented, black and white understanding of life and of the world. Schooling discourages doubting and questioning. For this reason, it is said that students enter school as question marks but leave as periods (Postman and Weingartner 1969) because all questions are answered and closed by the voice of authority. Perkins (2009, p. 9) further asserts: "Much of formal education is short on threshold experiences. It feels like learning the pieces of a picture puzzle that never gets put together, or learning about the puzzle without being able to touch the pieces… [Consequently,] we feel that we are playing the school game and not the *real* game." Given this state of affairs, it is unsurprising that a primary outcome of schooling is "inert knowledge" (Whitehead 1929).

1.4.1 Needs

The misplaced emphasis on schooling children is typically achieved at the expense of educating them. Gee (2013) argues that "[e]ducation must focus on giving every member of society a valued life and the ability to contribute, to learn how to learn, and to adapt to changing times. It has to create a sense of equality at the level not of status or jobs per se, but at the level of participation in knowledge, innovation, and national and global citizenship for a smarter, safer, and better world" (p. 205). Unfortunately, successful schooling is today often seen as the pathway to desirable jobs, a good career, high earnings, and nothing more.

For social and political reasons, schools continue to aim for and produce outcomes directed toward the past—what Marshall McLuhan calls the "rearview-mirror syndrome" (cited in Postman and Weingartner 1969)—because education stakeholders continue to fix their gaze not on where they are going but where they came from. A twenty-first century education, however, demands that we develop students' ability to learn how to learn and to innovate (Trilling and Fadel 2009). Such an education is not content-centric and not solely cognitive, directed toward rote memorization and information regurgitation. In particular, such an education requires students to learn to *be* critical thinkers and problem solvers (not merely learn *about* critical thinking and problem-solving), learn to *be* complex communicators (not merely learn *about* complex communication), and learn to *be* creative and innovative (not merely learn *about* creativity and innovation). In other words, schools must help students to *become* more critical thinkers and problem solvers, *become* more complex communicators, and *become* more creative and innovative persons. For such an education to be realized, students must first be supported to develop their *own* powers of thinking and learn to think *for themselves,* instead of persistently (and all too often blindly and unquestioningly) searching for answers by means of Google search, believing that "Google has all the (right) answers to all my questions." Such misdirected faith in Google, premised on the mistaken belief that knowledge is constituted by a linear accumulation of objective facts about the world that have been "scientifically discovered" in the past, serves only to reinforce the rearview-mirror syndrome.

Schooling practices suffused with hind vision rather than forward vision do not cultivate the interrogative and creative mind-set needed for innovation and inventive problem-solving: traits that remain in extremely short supply today. All too often, it merely equips students to know about a world that no longer exists. The world that no longer exists is one that is fixed and seemingly constituted by eternal verities. Advances in our understanding of physics and biology inform us that the natural world is an open, dynamic, and largely unpredictable complex system where change and process are the only constants. The modernist quest for closure and determinism that would grant full control over phenomena and the associated power of ironclad prediction is but an illusion (Doll 1993). The seeming regularities that we see in (strictly, impute to) the world are only stability patterns of different degree (Chee 2014) . In such a world, how should curriculum be designed? The design of school curricula continues to resist current understandings of the world gleaned from science, as manifested by continued adherence to Tylerian principles of curriculum design that assume (1) a deterministic, cause-and-effect relationship between an authority-determined set of learning objectives and an associated set of instructional means or procedures, and (2) a positivist epistemology that assumes human knowledge is independent of human knowers and that the path to such knowledge is through fortuitous "discovery" (Tyler 1950).

The worldview described above resists accepting that human knowledge is socially constructed through and through and, hence, that it does not occur independently of human purposes, biases, assumptions, and limitations in the pursuit of knowledge. The activities of knowledge construction and science making are deeply predicated on the process of dialog because they are, at heart, activities of human meaning making. Human meaning (as a verb) is something that people do. They do it with textual representations, and they do it with other people. Meaning cannot be "extracted" from inert textual representation; it must be constructed by entering into dialog with a text (Bakhtin 1981). A further pressing need for education today, given the widespread ethnic, sectarian, religious, and ideological strifes that engulf us, is to help students cultivate a dialogic disposition, rooted in dialogic being. That is, twenty-first century education needs to foster the mind-set and attitude of being open to and respectful of alternative viewpoints, voices, and values, based on the premise that, in the organization and practice of human living, there is no single "right answer:" the product of a singular, monologic, authoritative voice. Rather, the world is filled with heterogeneous voices and a multiplicity of cultural practices and values, such that developing mutual respect for others and for other perspectives is the best approach to dealing with the human condition we find ourselves in. In this spirit, Wegerif (2013) argues not only for education *through* dialog but also education *for* dialog; that is, dialog should not be only epistemological, a way for knowing, but also ontological, a way of being. Good education, he says, is "more importantly, about expanding the capacity to participate in dialogue" (p. 5).

1.4.2 Challenges

It is entirely possible, and indeed quite likely, that not all readers will entirely agree with what I have articulated above because the field of education is highly contested—thus political—and replete with conflicting values, visions, and purposes. As Macdonald and Hursh (2006) argue, moving schools to (genuinely) focus on twenty-first century student learning, rather than on twentieth-century instruction, requires a paradigm shift that depends on changing both political attitudes and teachers' philosophy and practice. While it is something easy to recommend, it is hard to fulfill because "it implies a change in control, in hierarchies and in mind-set. Central control of school knowledge, deskilling of teachers and micro-management of teaching are designed to underpin instructional regimes" (Macdonald and Hursh 2006, p. 197) rather than learning regimes. As further illuminated by Youdell (2011), "[s]chools are shaped by the wider political and social context which is reflected in education policy and legislation that delineates what education is and constrains what schooling can be. In turn, schools become sites where these wider economic, political and social issues are played out through organizational structures and systems, the curriculum and pedagogy and the subjectivities available to teachers and students; where educators and students are managed, monitored, compared and held accountable; and where normative understandings of schooling and its subjects are sedimented" (p. 7). Understood in this more critical light, it is perhaps unsurprising that the process of education reform, and even school improvement, has been fraught with much anxiety and distress (Evans 2001) .

With respect to technology use—including the technology of digital games—in the context of school improvement, issues related to power, politics, conflict, control, empowerment, equality, social justice, and participatory democracy are all operative. In policy formulation related to technology use in schools, Selwyn (2011) argues that such policies are, in general, not intended to lead to social restratification or significant realignment of school systems along digital lines. Rather, technology policy can be understood primarily as symbolic interventions on the part of the state to maintain legitimacy through discursive means, such as by propagating the message that technology is being used to transform public sector practices, including school practices, and to enhance economic and international market competitiveness in a globalized world. While such policy direction setting and implementation contribute in part to intended outcomes, they also entail unintended consequences that become apparent only at a localized level, when managers, administrators, teachers, and students enact the policy edicts in schools.

Hodas (1996) further informs us that the institutional values of schools tend to coalesce into a general organizational culture based on respect for hierarchy, competitive individualization, division of knowledge into segments susceptible to mastery, and a receptivity to being ranked and judged. As such, schools "seek nothing so much as their own perpetuity" (p. 198), and this leads to an innate conservatism and natural resistance to change related both to the use and to the non-use of digital technologies. Use or non-use is, in part, a function of teachers' ongoing negotiations of their day-to-day work. Technology use is generally accepted when teachers perceive congruence and a good fit between the technology's affordances and the teacher's concerns in fulfilling her job of teaching. Given that teaching in the form of content presentation continues to dominate, it is unsurprising to find that digital technologies that can empower students in their learning lack traction with teachers. Underlying this coolness to technology adoption are issues of "efficient" use of classroom time, maintaining control over discipline, exercising authority over students, and faring well on institutional metrics of performativity and productivity (Selwyn 2011). On their part, students can also be agents of resistance as they attempt to make sense of how the introduction of some new form of digital technology into playing the game of school impacts their role of "being a student" subject to the traditional regimen of school. Garrison and Bromley (2004) tell of how students in the USA engage in what they term "defensive learning" by going off-task under the pretense of superficial busyness or by withdrawing intellectual effort under the guise of technological incompetence, these being manifestations of an "alternative" intelligence.

From the foregoing discussion, it should be evident that the appropriation of digital technologies into the everyday practices of the school, as represented by key stakeholders such as national governments, school boards, school leaders, teachers, and students, is a messy and tangled affair.[5] Consequently, it is vital, when considering the arguments made in this book for the power of digital games in education, to remember that for this potential to be realized, the challenges explicated in this section, and the potential pitfalls subsumed in the sociopolitical milieu, will need to be adequately negotiated and overcome.

1.5 Overview of This Book

In this chapter, I have outlined an argument for the use of digital games in education and provided the context—in terms of competing approaches to the use of games and the general educational context as the site for the adoption of digital games—for their potential use. In doing so, I hope to have furnished readers with an informed and critical perspective by which to understand and evaluate the power of digital game-based learning in formal education. Chaps. 2 and 3 constitute the heart of the "theory" chapters as they address the conceptual ideas that ground this work. In particular, Chap. 2 highlights and articulates the difference between what I refer to as "games-to-teach" vis-a-vis "games-to-learn" and explains why this conceptual distinction is important. Chap. 3 proceeds to explain the construct of performance, which serves as the key theoretical framing of my approach to researching and implementing game-based learning in schools.

Chapters 4 through 6 document case examples of game-based learning in schools, across three different domains at the secondary school level. The *Statecraft X* curriculum is located in social studies, the *Legends of Alkhimia* curriculum deals with chemistry, and the *Escape from Centauri 7* curriculum addresses physics. Chap. 7 revisits and expands on the challenge of game-based learning in relation to school reform. This chapter draws upon my research on teacher professional development to strengthen teachers' ability to enact game-based learning in the classroom. The final chapter, Chap. 8, steps back to reflect on the future prospects and educational opportunities for the adoption of digital games in service of education (rather than schooling).

[5] In this discussion, I have not addressed parents, another critical stakeholder in the ecology of schooling, because this group has been less well researched. Suffice to say that parents want to see their children do well, and this usually translates quite directly into meaning that they want to see their children excel in the conventional game of "business-as-usual" schooling.

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Chapter 2
Games-to-Teach or Games-to-Learn: What's the Difference and Why It Matters

In this chapter, I articulate the distinction between what I refer to as "games-to-teach" and "games-to-learn." I critically interrogate why games-to-teach are deeply problematic if the goal is to educate rather than school children. I do so from the perspectives of knowing, being, doing, and valuing; i.e., from epistemological, ontological, praxiological, and axiological frames of reference. I then elaborate on the vital differences between the two perspectives from the standpoint of making a commitment to schooling children or to educating them.

2.1 Games-to-Teach

The activity of play has permeated human culture from the earliest days of civilization (Huizinga 1938/1955). Play continues to be widely acknowledged as an essential means through which young children learn and develop cognitively and socially (Pellegrini 2009). Technology-based modes of play, accessed via virtual environments and digital games, have become commonplace in children's lives due to rapid penetration of personal computers and mobile digital devices in developed and developing economies, attendant upon the enhanced performance of hardware and on falling prices. Given this context, it is perhaps not surprising that from the late 1970s until well into the 1990s, there was a thriving market for children's educational software that rode upon the affordances of multimedia and animation that permitted the presentation of subject content in more attractive and engaging ways (Ito 2009).

The publication of Prensky's (2001) book on "Digital Game-based Learning" can perhaps be understood as a logical development and part of the evolution of

Y.S. Chee, *Games-To-Teach or Games-To-Learn*,
Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_2

digital games for learning. Seen in this historical light, it is telling that Prensky defined digital game-based learning in the following terms:

> Most simply put, Digital Game-Based Learning is any marriage of *educational content* and computer games. The premise behind Digital Game-Based Learning is that it is possible to combine computer video games with a wide variety of *educational content*, achieving as good or better results as through traditional learning methods in the process. (pp. 145–146, italics added)

Repeated emphasis on educational content coupled with a comparison with traditional learning methods suggests a lack of dissatisfaction with “business-as-usual” schooling (Youdell 2011) or, at least, contentment with the *status quo* in children’s formal education, except for one thing: unhappiness over how school learning often leads to disinterested and disengaged students. Prensky describes his professional focus as “reinventing the learning process to provide more engagement, combining the motivation of video games and other highly engaging activities with the driest content of education” (Prensky 2006, p. 253). Might there be a deep contradiction in wanting to enhance students’ motivation and engagement for the driest content of education?

Insistence on educational content that students are supposed to learn suggests an overly narrow understanding of and vision for education, especially twenty-first-century education. Content centricity succumbs to Postman and Weingartner’s (1969) critique of the idea that a classroom lesson comprises two components: content and method. Content is considered to be the “substance” of the lesson: It is something that students are supposed to “get.” Content is conceived of as having independent and prior existence to students, and it is indifferent to the media by which it is “transmitted.” Method, on the other hand, concerns the manner in which content is presented, whether it is achieved by means of a computer game or some other means. Such thinking is rooted in the tradition of instructional design (Smith and Ragan 1999), which arose during the Second World War as a mechanistic process for producing reliable training. It combines the ideas of operant conditioning and reinforcement with communications theory that emphasizes the conveyance of ideas (Jonassen and Land 2000) and views learning as entailing knowledge transmission accompanied by drill and practice.

I turn now to critically examining several examples of educational games that can be found on the Internet. These games provide the reader with concrete examples of games-to-teach. They are located in the domain of chemistry. They came to light during the process of searching for “state-of-the-art” chemistry games, as part of developing the curriculum for our chemistry game *Legends of Alkhimia*.[1]

A certain online Web site hosts a chemistry “game” that is positioned in the following way. On accessing the Web page, one is presented with a screen that states:

[1]See Chap. 5 for details.

"This is a fun little game that quizzes you on element names, symbols, and uses." Clicking the button "Start Element Quiz," a student is presented with a question such as:

Hydrogen is

(a) H
(b) Yd
(c) He
(d) Hg

The page also contains an on-screen hyperlink that says, "How do I play this?" Clicking the hyperlink yields the following instructions: "Click on the answer link for each question and a message will pop up letting you know if it's correct. If you miss one of the 43 questions, don't worry, it'll come up again until you get it right."

It requires little intelligence to discern that this "game" is merely a multiple-choice question, a popular mode of assessment in schools, disguised as a game. It is striking how the author of the Web site positions the activity as "a fun little game" and going so far as to pose the question "How do I *play* this?" to users. It is perhaps even more remarkable that the author appears to attach great value to students mastering fragments of "factual" content, such as "Hydrogen is H." This example illustrates how laypersons tacitly understand, and thus frame, the activity of formal education in terms of the mastery of content accomplished by means of some instructional method.

My second example is drawn from a fee-paying Web portal that ostensibly markets educational games. One such game deals with the periodic table. Students are shown a diagram of the periodic table with this instruction: "Click on the element with the atomic mass of 58.693." In all likelihood, a student will engage in this activity by making random guesses. Selecting an incorrect answer triggers the following system response: "Oops, that is incorrect. Please try again." If the student tries again and still selects an incorrect element—a very likely outcome given that there are 106 different elements to choose from—the system flashes the correct answer, which happens to be "Ni," representing the element nickel. Selecting the Ni button leads to the system feedback "Correct!!!" accompanied by presentation of extensive information about nickel, which students are presumably expected to remember. It should be apparent that this "game" reduces to a trivial exercise in the delayed presentation of subject content. Although this activity has an impressive user interface, it is ill conceived from a pedagogical point of view.

My third and final example revolves around the use of chemical equations. Yet another chemistry Web site seeks to teach students how to balance such equations correctly. On an interface comprising textual instruction and molecular representations, students are asked to "balance the equation for the combustion of methane." On the left side, the "Reactants" methane and oxygen are shown. On the right side, the "Products" carbon dioxide and water are shown. The following instruction is given: "Click on each of the molecules in turn, until you have a balanced equation, then click OK." The original, unbalanced equation shown is:

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

while the correct balanced equation is:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

That is, one molecule of methane and two molecules of oxygen react to form one molecule of carbon dioxide and two molecules of water. Given that the molecular products of the reaction are already shown in the original equation, the exercise reduces to an arithmetic manipulation to ensure that the number of each type of element is the same on the left-hand side and the right-hand side. No substantive understanding of the chemical reaction is needed to obtain the right answer.

The three examples described above may be regarded as a continuation of the kind of thinking that pervaded the era of computer-aided instruction (CAI). CAI software was designed to drill students to obtain correct answers to questions framed such that they would have unambiguously "right" versus "wrong" answers. In this context, "right" answers are authority determined. Thus, even complex questions that, in principle, offer no unambiguously "right" answer—for example, "what is a good citizen?"—are railroaded into a clichéd format that conforms to the a priori requirement of there being a "right" answer. Unfortunately, this right-versus-wrong answer mind-set carried over into the field of intelligent tutoring systems (ITS) in the 1980s and 1990s where computerized tutors, augmented with the powers of artificial intelligence, were developed to train students to obtain right answers in problem-solving domains such as arithmetic, geometry, and algebra (Larkin and Chabay 1992). Concerns over effectiveness (getting the right answer) and efficiency (getting the right answer in the least amount of time) were paramount in the design of such tutors. Making mistakes in the process of problem solving was viewed as inefficient and a "waste of time." Hence, it was something to be avoided. In short, making mistakes was seen as having no value in relation to the learning process. The mantra of "getting it right in the shortest time" became dogma.[2] There was little understanding of and tolerance for the importance of expectation failure (Schank 2002), arising from the commission of error to the learning *process*. Educators were—and continue to be—fixated on learning *products* or outcomes. Consequently, they do not focus on learn*ing* as such.

Another type of online learning tool positioned as an educational "game" is the virtual chemistry laboratory. Such virtual laboratories are designed to replace the procedures that students traditionally perform in a school chemistry

[2]There is nothing wrong, of course, in wanting students to be able to generate the correct answer to mathematical problems. The issue here is that for a deep *understanding* of the problem space to be achieved, students need to grasp the solution space *in relation to* the error space. This point is elaborated later.

laboratory with an online virtual version. They may support fairly sophisticated manipulation of laboratory equipment and performance of experiment procedures, but always subject to the condition that students execute mandated steps in a predetermined sequence the way they normally do in school. In short, students are not permitted to experiment when performing the (predetermined) experiment: a self-contradicting design for learning. Prensky argues the need to distinguish between simulations and games. He states that a "pure simulation" focuses on the thing or process being simulated, while a "pure game" focuses on the user's experience. A pure simulation is intended to support practice. It copies reality, is life-paced, assumes an externally defined meaning, and entails no goals, story, or struggle. Pure games, by contrast, include elements of fantasy, are game-paced, require students to construct their own meaning, and involve struggle to achieve meaningful goals within a narrative flow. From this perspective, virtual chemistry laboratories are simulations rather than games. As evident from the foregoing explanation, they replicate schooling practices, albeit in a digital format.

Based on the foregoing examples, it seems reasonable to infer the following. First, there is widespread preoccupation, among game designers and developers (and likely instructional designers as well, to the extent that such professionals are involved in the game design process), with using educational games as tools for teaching subject content. To the extent that such games focus on skills, they do so in a limited way that emphasizes strict execution of correct procedure. Second, with respect both to learning domain content and skills, the stress is on "getting it right." Any outcome that diverges from the prescribed "right answer" and "right procedure" is regarded as having no value. Consequently, the commission of errors by students, as part of the learning process, is viewed as inefficient and undesirable. Hence, it is something that should be avoided. Third, game designers and instructional designers have weak understanding of epistemology that is essential to effectively design for human learning. Specifically, they fail to understand that human meaning making is relational in nature. Just as the conceptual idea "black" has meaning only in relation to its opposite, "white," a "right" or correct answer can acquire its sense of "rightness" only in relation to all that is "not right." But if students are discouraged, even precluded as in the virtual chemistry laboratory, from experiencing why wrong answers are "not right," their understanding of why right answers are "right" will be fragile at best. In such a circumstance, the warrant for "rightness" can only be based on authority. Thus, when asked for an explanation for why some claim is correct, students can only appeal to an authoritative source—be it the teacher or the textbook—as the basis of their claim, given that they have no personal basis that can serve as warrant for the claim. Lacking the opportunity to engage in a rich meaning-making process that entails making mistakes—something that games readily afford—students frequently end up "knowing the facts" but without a working understanding of what they know.

2.2 Interrogating the Thinking Underlying Games-to-Teach

In this section, I interrogate the conundrum of "knowing" and yet not understanding alluded to in the preceding section. I do so in terms of four distinct facets of what I shall later argue are interrelated aspects of a common underlying theoretical problem. These four facets are the epistemological, ontological, praxiological, and axiological aspects of human behavior.

2.2.1 Epistemological Confusions

Epistemology addresses the subject of knowledge and how we, as humans, come to know. Although epistemology is of deep relevance and consequence to education, it is perhaps a sad reflection of the normative emphasis on schooling rather than educating that the typical schooled adult lacks substantive understanding of this subject matter.

Typical adults tend to think of knowledge as something that a person "has." People with "more knowledge" are deemed to be better off than those with "less knowledge." Furthermore, libraries are commonly regarded as storehouses of knowledge. With the advent of the Internet, knowledge is widely viewed as "residing online" in formal repositories such as Wikipedia, as well as other institutional and personal Web pages.

Thinking about knowledge in the manner described above, however, is deeply problematic from an epistemological point of view. First, knowledge is conceived of as an object; hence, it is some *thing* that a person can "have." Such thinking is erroneous and is a manifestation of what I refer to as the *fallacy of knowledge possession*. An illustration might be helpful. A newspaper article that I read sometime ago sought to highlight how easily students today can "obtain knowledge" from the Internet. The title of the article boldly proclaimed "Trawling for knowledge." Drawing upon the conceptual and evocative power of metaphor (Lakoff and Johnson 1980), the writer portrayed knowledge as being like fish: some *thing* that can be "caught" by trawling, presumably by using an Internet search engine such as Google Search. But can knowledge really be "caught"? If knowledge is indeed catchable, would teaching not be reducible to the simple act of giving students handouts or assigning bookmarked Web pages to read: a case of "sharing the fish caught," as it were?

Schoolteachers often instruct young children to "find" the meaning of a word they do not know by looking it up *in* a dictionary. Suppose that a child encounters the word "rhinoceros" in a (non-picture) book for the first time. Not knowing what the word means, she searches the dictionary and finds the following definition: "massive horned mammal." Delighted, she memorizes this definition and thinks that she now knows what a rhinoceros is. In other words, she thinks that she is now in possession of "new knowledge." While such new knowledge might serve her well in multiple-choice tests in school that require the recognition of a correct definition of what a rhinoceros is, would she necessarily recognize one when she encounters it in the zoo or in the wild? The answer is an emphatic "No." Knowing the textual definition of the word "rhinoceros" does not translate into knowing what a rhinoceros is in the real world because all that (printed) dictionaries contain is carbon on paper. Just as a laser printer prints pages by fusing carbon powder in the toner cartridge onto the page, a (printed) dictionary likewise only contains carbon on paper. Consequently, such dictionaries do not contain word meanings and, hence, do not contain knowledge The textual, symbolic forms inscribed in carbon on the pages of a dictionary are, in and of themselves, inert and meaning-free. Hence, they do not constitute knowledge. All dictionary users must make the effort to *interpret* the inherently meaningless representations found in dictionaries to render the representations personally meaningful. Only then can they be said to know.[3] Consequently, human knowing entails engagement in a meaning-making process. Possession of representations of knowledge, such as dictionary definitions, does not translated directly to, and hence is not equivalent to, knowing. As Korzybski (1994) argued, the map is not the territory. Consequently, having possession of the map, which is merely a form of pictorial representation, does not translate directly to being able to navigate the territory represented by the map. While the map may be an aid to navigating the territory, it does not, of itself, bestow the capacity to navigate the territory represented. In short, possessing a *representation* of knowledge is clearly not the same as having knowledge as such because to genuinely "have knowledge" requires the concomitant capacity to act in ways consistent with that knowing. From the foregoing, it also follows that merely being able to repeat a dictionary definition or to regurgitate memorized passages from a textbook or from the Internet fails as a test of knowing. To believe otherwise is to fall prey to what I call the *inadequacy of knowledge profession*. Being able only to profess through a linguistic means of expression—as is the case with oral and written examinations held in schools—merely perpetuates the illusion of knowing when a student only knows *about* something. Just as knowing swimming differs vastly in its entailments from knowing *about* swimming, the restricted capacity for profession, without a concomitant capacity to act upon one's profession, manifests a pervasive outcome of school-based learning, namely inert knowledge (Whitehead 1929).

The second reason why the primary error of treating knowledge as an object is problematic is that such thinking leads to the secondary error of believing that knowledge can be measured and quantified. While a student can be in possession of a greater or lesser amount of knowledge representations—for example, through the quantity of information resources, such as textbooks, that she possesses—it

[3]Whether they know "correctly" or otherwise—that is, whether they genuinely understand—is a separate matter.

makes little sense to speak of having more or less knowledge if one accepts that knowledge is not a thing to begin with.

Third, to think that knowledge can be stored in online digital repositories, as well as physical media and books for that matter, is to commit the *error of knowledge reification*. Delivering his presidential address to the American Association for Artificial Intelligence in 1980, Allen Newell expressed serious misgivings about the widespread conception of knowledge as a thing. He argued that such thinking conflates knowledge and its representation. While knowledge representation takes a material form, knowledge, Newell suggested, "is a competence-like notion, being a potential for generating *action*" (Newell 1982, p. 100, italics added). In the context of artificial intelligence, encoded representations of machine behaviors have the potential for generating actions useful to humans. However, Newell recognized that the representations alone were incapable of any such action. Thus, he sought to reconstruct the notion of knowledge as some kind of material stuff in terms of "actionable knowledge" instead, so as to distinguish knowledge from its inert representation. This idea of actionable knowledge is precisely what Dewey and Bentley (1949/1991), in their seminal work *Knowing and the Known*, refer to as "knowing." Thus, when a person acts in a knowing way—that is, in an informed manner when in a specific situation—laypeople impute the person with "having" knowledge. But this "having" arises from imputation, as a matter of custom and social habit, rather than as a scientific fact.[4] This social practice leads directly to the fallacy of knowledge possession described earlier.

From the foregoing, we may conclude that the thinking underlying games-to-teach is based on the epistemological error of conflating human knowing with the possession of representations of knowledge. Avoiding the fallacy of knowledge possession leads to my argument in Chap. 3 for the necessity of framing learning in terms of human performance—a central tenet of this book.

2.2.2 Ontological Errors

Ontology is the branch of classical Western philosophy that deals with the principles of pure being; that is, it addresses the question of existence and of "what *is*." A key idea from ancient Greek thought concerns the idea of *theoria*, which refers to the activity of mental contemplation directed toward the establishment of truth. *Theoria* was juxtaposed against *praxis*, which relates to the realm of human action in the lived and sensed world. According to Aristotle, *theoria* is directed toward the "eternal and unchanging *objects* and is the highest and best activity of which a human being is capable. A man engages in contemplation not *qua* man but in

[4]A person who is asked to show you his or her knowledge (as a material object) will be hard pressed to do so. Laypeople may be apt to point to their heads, but when pressed further to be more specific, they are likely to show signs of exasperation.

virtue of the divine intellect (*nous*) in him. Contemplation is higher than *practical reason* and is the supremely valuable life, providing complete human happiness" (Bunin and Yu 2009, p. 684). Truth, for Plato, is exemplified in mathematics and geometry, and it can only be apprehended through the exercise of rational thought. The world perceived with our senses—that is, *phenomena*—is only a corrupted copy of this ideal Truth. But beyond this world of phenomena, Plato believed that there lies a *fixed* world of Ideas—a kind of transcendent Platonic heaven—that is the real object of knowledge, namely (eternal) Truth. Based on Plato's theory of forms, this truth constitutes ultimate *reality*. Based on this general worldview, it is hardly surprising that the ancient Greeks prioritized rational thought above action in the world. Western thinking, as a legacy of ancient Greek thought, continues to embody this bias.

The notion that there is a world of fixed and eternal ideas—namely, Truth—that can be discerned through focused mental contemplation has led, through the history of premodern and modern times, to the prioritization of representational forms, language being the most dominant form, that supposedly mirror how things are in the world. However, Rorty (1979) has cogently argued in this seminal work, *Philosophy and the Mirror of Nature*, that assuming a correspondence between a word, proposition, or thought to some objective reality or truth presupposes a correspondence theory of language—an ontological assumption—and a spectator theory of knowledge—an epistemological assumption. Unfortunately, both assumptions are seriously flawed. We know, from the domain of semiotics and language studies, that the relation between a word and its meaning in the world is entirely arbitrary (Hayakawa and Hayakawa 1990). Two people can use the same word to mean very different things, and consequently, the correspondence theory of language fails. Likewise, two people who share a common experience—say that of witnessing a car accident while walking together along a road—can (and, as a practical matter, invariably will) express that experience in different words because it is not possible for them to stand removed from the phenomenon of concern and render a singular impartial and objective account of what was "actually seen." The spectator theory of knowledge, however, assumes that people possess a kind of "immaterial eye" that can impartially view what is taking place in the "reality" that lies before them and thereby render a unique "objective" account of what took place. Clearly, this is not possible, and hence, the spectator theory of knowledge is also rendered false. Consequently, what humans know—commonly spoken of as their knowledge—is formed through a sociocultural process that requires interpretation and construction. What they know does not, and cannot, arise merely from "recording," "finding," or "discovering" it. As humans, we do not have the privilege of adopting a God's-eye-view of the world and to see the "true" account of "how things really are." Rather, we were born into the world and became socialized into our roles and positions in the world long before we could even consider engaging in inquiry or scientific research. Consequently, our engagement in such enterprises is fully impregnated with values, beliefs, and understandings that arise from prior enculturated practice in this world. To think otherwise would be to fall prey to what Dewey (1925/1988) called *the philosophic* *fallacy*, namely the error of "confusing the *consequences* of linguistic meaning making and logical inquiry with *antecedent* metaphysical existence" (Garrison 1999, p. 929). In short, Dewey emphasized the importance of acknowledging that words and language are a human construction that comes *after* the existence of the physical world, and not before. Regrettably, many philosophers, educators, and laypersons continue, like Descartes, to uphold the dictum of *cogito ergo sum*—I think therefore I am—thereby assuming the possibility of thinking as prior to being. In doing so, they commit the error of assuming the existence and availability of language for thinking before granting the existence of the physical world, and of themselves, to which that thinking is directed.

The ontological errors described above are further compounded by the *error of hypostatization*: construing purely conceptual entities as having real existence. In his celebrated book *The Concept of Mind*, Ryle (1949/2009) describes the case of a foreign visitor being shown around his university. As described by Greetham (2006, p. 208):

> He sees the colleges, the libraries, the playing fields, the museums, the scientific departments and the administrative offices. And then, having seen all this, he asks "But where is the university?" He has made a category mistake in that he has assumed that the university is an entity over and beyond what he has seen.

It is vital to grasp that "the university" as an entity is purely conceptual and ideational. It has no separate material existence. Consequently, in the physical sense, it is not "real." It is essential, therefore, to distinguish between the reality of physical objects that we apprehend directly through our senses and the "ideational reality" of human concepts that arise solely from natural language and our capacity for language use. This language capacity gives rise to our further ability to construct multiple layers of abstraction, with each layer possessing less detail and specificity. Thus, Hayakawa and Hayakawa (1990) speak of the operation of the abstraction ladder in everyday language use. They cite the following as an example of climbing the ladder of abstraction: "Bessie" (the name of a particular cow)—"cow"—"livestock"—"farm assets"—"asset"—"wealth." It should be evident that as we move up the abstraction ladder, each category term becomes more general, and hence less concrete, and also subsumes all lower category terms. Thus, cows are a type of livestock; livestock are a type of farm assets, etc. Because higher order categories become more abstract, we are less able to derive a *sense* of what they refer to. Like the concept of "university," these terms, brought forth through language, have no physical existence. Hence, in this sense, they do not exist.

What exists then? Continuing with Hayakawa and Hayakawa's example, we find two additional levels depicted as we go *down* the abstraction ladder. Beneath the level "Bessie," the name of the particular cow that we observe lies the wordless level at which the cow is perceived and experienced, as determined by our human nervous system. Moving yet another level down the ladder, we arrive at the *process* level wherein the specific instance of the cow being observed is constituted by the elements—atoms, electrons, etc., as made out by present scientific understanding—out of which it is composed. This level is a complex of interactions that is continually changing and whose characteristics are, in principle, infinite. Consequently, when we think of what we are seeing and experiencing as a type of animal—namely, a cow—we are already abstracting multiple levels away from the process level and reducing the richness and multiplicity of the process reality of the cow. Viewed in this light, we come to understand that what is generally called Nature is a "primary reality" that is wordless and antedates humankind. It is the world of physical and material existence. Our capacity for language, however, allows us, as humans, to engender and bring forth a "secondary reality" that is ideational and conceptual. However, we must recognize that if students only have access to this secondary reality at the expense of access to primary reality, they would be just like the students (referred to in Sect. 2.2.1) who can only speak and write *about* swimming but not be able to swim. Such learning would be impoverished, indeed bankrupt, because it creates little or no value for students as individuals. The ability *only* to use words—as is often the case in school-based assignments and examinations—is akin to building castles in the air because the words used are unanchored, ungrounded, and not rooted in the reality of living and acting in world. There are two important takeaways to be cognizant of then. First, primary reality is not constituted of or from words. Consequently, learning that revolves around the "play of language" alone is debilitating at best. If learning is to be of value to students, it must empower them to *act* in the world to create value for themselves, as well as for others in their family, community, and society. Second, from an ontological point of view, primary reality does not consist of objects—ideational or otherwise—that are fixed and eternal, as made out by Plato and the ancient Greeks. Rather, primary reality is fundamentally a process, characterized by ongoing flux and change. This metaphysical worldview, antagonistic to the object ontology of the early Greeks and which is still dominant in lay thinking today, is well established in the domain of process philosophy (Chee 2010, 2014; Mesle 2008; Rescher 1996, 2000).[5]

Getting a grip on the deep ontological errors articulated here helps us to approach learning in a different light. It should now be evident that the value attached to "having knowledge," to "knowing stuff," and to developing cognitively oriented skills in the absence of developing the ability to do useful things related to such knowing and thinking would be to miss the forest for the trees. The consequence is a form of learning that is domesticated because it is reduced to that which is easy to instruct and assess, with student disengagement as a widespread side effect.

To summarize, we must understand the following key ideas. First, what humans know arises from a process of social construction rather than one of discovery of eternal and immutable Truth; consequently, human understanding shifts over time. Second, language allows us to create a secondary reality based on words, but words on their own furnish no access to the primary reality of Nature;

[5]The implications of adopting a process-relational worldview are vast and beyond the scope of this chapter.

consequently, we should not believe that abstract words refer to real, material objects. Third, teaching and learning that is based on the use of language alone, whether written, spoken, or both, is misdirected because it does not empower students or grant them agency with respect to what they know *about*.

In closing this section on ontological errors, I draw attention to a further related issue: that of the interdependence between epistemology and ontology. What there is (ontology)—insofar as we can make it out, scientifically or otherwise—is dependent on how we come to know (epistemology). Access to new forms of scientific instrumentation, such as microscopes and telescopes, has thus been instrumental to the ways in which our understanding of the world has advanced. By the same token, our coming to know what we now know (epistemology) is dependent upon the nature of primary reality; that is, on what there is (ontology). Consequently, ontology is a function of epistemology and vice versa. As both ontology and epistemology are each dependent on the other, the two are inseparable in principle. This insight unravels yet another tenet of classical Western philosophy, derived from the Greeks, which treats ontology as an independent subject of study from epistemology, thereby creating a false dualism. Given their mutual interdependence, ontology–epistemology is constituted by a unity and hence must always be considered together. For the sake of conceptual clarity, I addressed these two aspects separately. But we must always remember that this domain, referred to in the literature as onto-epistemology, is a singular domain (Barad 2003, 2007).

2.2.3 Anti-praxiological Bias

The onto-epistemological issues discussed above have led to preoccupation with language-based symbolic representations in the activity of schooling, at the expense of helping students develop the capacity for performing personally meaningful and socially useful activities with what they supposedly know. Grounded upon a bias that favors *theoria*, the realm of *praxis*—relating to human action in the lived and sensed world—has traditionally been regarded as deficient and inferior owing to the inescapable contingency and particularity of its objects of concern (Fairfield 2000). Modern foundationalist thinking (Brown and Stenner 2009; Fairfield 2000), perpetuating Platonic thinking, attempts to generalize and theorize from a vantage point *external* to human practice on the premise that practice, if it is to be done "right," needs to be grounded upon some higher order set of axiomatic tenets so that certain knowledge can be derived. As Dewey (1929/2008) argued, however, the quest for certainty is illusory because there is no thing, end, or essence that is eternal, immutable, or necessary: "A thing may endure … and yet not be everlasting; it will crumble before the gnawing tooth of time, as it exceeds a certain measure" (cited in Garrison 1999, p. 294). Furthermore, contemplation alone, in the quest for theory, can never bootstrap the knowledge construction process because, as Aristotle (1941) himself acknowledged, if we are to be always deliberating, we shall go on to infinity.

Understood in this light, it is not difficult to grasp why Bloom's taxonomy of educational objectives in the cognitive domain (Bloom et al. 1956) remains dear to the heart of instructional designers and school practitioners alike. These professionals subscribe to the notion of "cognitive levels" of increasing mental complexity of school-based tasks reflected in the categories (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation. The formulation of these cognitive levels serves as a crutch, external to practice, which can be drawn upon to direct the design of instruction. Whether one adheres to Bloom's original formulation or to some more current variant, such as the one put forward by Marzano and Kendall (2007), the substance of the cognitive aspects of the taxonomy remains the same. Marzano and Kendall augment Bloom's formulation by adding consideration of metacognition and what they call "self-system thinking," to encompass attitudes, beliefs, and emotions. While this move may not be a bad thing in itself, two critical weaknesses remain. First, their conception and treatment of the cognitive system remain rooted in the psychology of human information processing, based on the computer metaphor, whose representational basis is known to be deeply problematic (Coulter and Sharrock 2007; Still and Costall 1991; Toomela and Valsiner 2010) and which has already been critiqued in the foregoing subsections. Second, Marzano and Kendall position themselves as offering something superior to what Bloom had to offer because their taxonomy, they say, "presents a model or a *theory* of human thought as opposed to a *framework*…. By definition, Bloom's Taxonomy is a framework in that it describes six general categories of information processing" (p. 18). Apart from the issue of remaining trapped in the metaphor of information processing, it must be understood that Bloom did not intend his six categories to be understood as increasing *levels* of cognitive complexity. His taxonomy constituted a codification of the kinds of questions that students in school faced in *his* time: that is, during the late 1940s to the early 1950s. In executing his work with his co-authors, "it was agreed that the taxonomy should be an educational—logical—classificatory system…. It was further agreed that in constructing the taxonomy, every effort should be made to *avoid value judgments* about objectives and behaviors" so that the taxonomy "would permit the inclusion of objectives from all educational orientations. Thus, it should be possible to classify all objectives which can be stated as *descriptions of student behavior*" (Bloom et al. 1956, pp. 6–7, italics added). Evidently, Bloom did not intend and never suggested the six categories of educational objectives be treated as a linear ordering implying increasing difficulty. Neither is there anything to suggest that Bloom and his co-authors intended that the classification was suitable as a basis for conducting student assessment. On the contrary, they spoke of the taxonomy expressly as descriptions of student behavior. The element of ordering and of implied progression appears to have been introduced, either intentionally or neglectfully, by practitioners of instructional design. For this reason, Marzano and Kendall's criticism of Bloom's taxonomy constituting only a framework is misdirected at best. It should also be emphasized that Bloom's taxonomy represents a codification of the types of questions asked in school assessments in *his* time. There is nothing to suggest that Bloom intended the taxonomy to apply to all peoples of the world for all time. Using Bloom' taxonomy, in whatever form, to design for student learning will serve only to perpetuate the practice of schooling and the attendant development of "inert knowledge" (Whitehead 1929).

If learning is to lead to actionable outcomes rather than "inert knowledge," it must be embedded in and take the form of meaningful real-world activity; that is, it must be located in human praxis. Dewey (1949/1991) argued that inquiry-based learning is central to the development of all (actionable) human knowing. Knowing, as inquiry, is triggered by the occurrence of some event, in the normal uninterrupted flow of life activity, which interferes with its ongoing and smooth flow. This interference deflects the activity into a "reflective channel" whereby the person deliberately contemplates the interference with a view to finding a way to resume the disrupted activity. The activity of knowing is thus always located in the lifeworld of human activity in which unexpected events, or problems, that arise are deliberated upon with a view to establishing a means for overcoming the encountered problem. Thus, as framed by Dewey (1949/1991, p. 323), knowing is "an intermediate and mediating way of behavior… constituted by determination of subjectmatters as on one hand means to consequences, and on the other hand of things as *consequences* of means used." As a result, human agents act upon hypothesized solutions to their problems and, in so doing, determine which hypothesized solution actually yielded the desired outcome. In this manner, learning, entailing both deliberation and action, is empirically grounded. Such learning also, as a by-product, establishes relations between means and ends so that should a similar situation arise in future, the problem does not have to be solved "from scratch." Instead, solutions that have been efficacious in the past are brought to bear upon fresh problems faced in the present. Framed in this manner, learning is said to be transactional "so that 'thing' is in action, and action is observable as thing, while all the distinctions between things and actions are taken as marking provisional stages of subject matter to be established through further inquiry" (Dewey and Bentley 1949/1991, pp. 113–114). Consequently, inquiry remains an open and ongoing process because conclusions drawn thus far, based on prior experience, are always provisional and subject to re-evaluation and revision. From the pragmatic stance of Dewey's philosophy (Garrison and Neiman 2003), knowing is thus a process that entails *both* existential and symbolic operations. In this way, the Gordian knot of mind–body dualism is severed. The existential realizes the means to consequences through action in the world, while the symbolic furnishes the mental projection of consequences that would arise from exercise of the means used. Subsequently, such action is no longer experimental but rather intentional, anticipatable, and instrumental. It thus allows for intelligent, meaningful, and targeted human behavior. In short, "real" learning takes place.

Based on the foregoing analysis, it should be evident why an emphasis on *theoria* and declarative modes of instruction, so widespread in schools, harbor an anti-praxiological bias. However, "the realm of *praxis* is the preeminent location in human existence of meaning and identity formation" (Fairfield 2000, p. 9). An anti-praxiological bias leads unsurprisingly to the malaise of "inert knowledge." In the absence of being given opportunities to act productively in pursuit of learning, meaning making and developing a sense of self are compromised. Learning only *about* subject matter creates little personal value for students. Games-to-teach are firmly located within this anti-praxiological agenda. They are non-empowering and give rise to disengagement from classroom lessons and disenchantment with what students are led to believe constitutes "education."

2.2.4 Axiological Neutrality

There is a pervasive belief that facts and values are fundamentally separate and independent of each other. Owing to the rise of modernity and advances in the physical sciences, "facts" are perceived as "real" and "objective." They are regarded as "proven knowledge" by laypersons and seen to be of universal application. "Facts" are accorded higher standing than "values," which are often described in disparaging terms such as "fuzzy," "subjective," and "unprovable." This difference in valuation between that which is ontological—pertaining to "facts"—and that which is axiological—pertaining to values—is especially evident in school curriculum, where the amount of time devoted to "hard" subjects such as science and mathematics far exceeds that allocated to "soft" subjects such as civics, moral education, and the literature. Furthermore, teaching of the "hard" subjects is conducted in a manner that positions subject domain "facts" as being completely objective and value-free. Unfortunately, such thinking is misguided because it fails to acknowledge that what is known in these domains, as with the "soft" subjects, is part and parcel of the *social* construction of reality as we know it (Berger and Luckmann 1966).

The idea that facts are independent of values is a myth. The social process of constructing what "is" is inherently inseparable from the exercise of human values subsumed in executing the process. This putative separation is rejected by Whitehead (Leue 2005) and by process philosophers. Putnam (2002) shows how normative judgments are presupposed in all aspects of human life, including intellectual life, and, consequently, the fact–value dichotomy collapses. To illustrate, theory construction in the hard sciences is driven by the value of parsimony, while the construction of theory in mathematics is driven by the value of elegance. Parsimony and elegance are altogether subjective human criteria. Similarly, reasoning about epistemology is significantly influenced by the values of consistency, coherence, applicability, and adequacy (Mesle 2008). These criteria are often applied tacitly and hence lurk in the background. Ferré (1996, p. 14) further argues that:

> our values precede our theories in real life and lead us in their construction (or approval). Even in the sciences, we have become aware of the degree to which expectations, including such factors as hopes and career commitments, influences what we notice within the total range of the presented data. Attention is selective. We should expect, therefore, that our values will have a role in suggesting possible fruitful lines of thought. In addition, these values will play a decisive role in influencing us on how long to hang on to a theory, model, or worldview threatened by problems.

It should be evident from the foregoing that human valuing is inseparable from all human being, doing, and knowing. The acts of human valuation—our valuings—directly indicate the kind of person that we, as humans, seek to become. They are based on an envisionment of the kind of social and cultural conditions that an individual believes is the one to be preferred. Values thus undergird the dispositions of individuals, leading them to act, as well as to prefer to act, in certain ways and not others. Values are central to the very notion of human existence. As expressed by Whitehead (1926, p. 100):

> Value is inherent in actuality itself. To be an actual entity is to have a self-interest. This self-interest is a feeling of self-valuation; it is an emotional tone. The value of other things, not one's self, is the derivative value of elements contributing to this ultimate self-interest. This self-interest is the interest of what one's existence. . . comes to. It is the ultimate enjoyment of being actual.

From the above, we see that contemporary schooling practices commit two grave injustices. First, by misrepresenting the inherently social underpinnings of the *practice* of the "hard" disciplines, it misleads students into believing that scientific theories become immutable when "proven," thereby failing to grant that scientific work can only falsify theories and never prove them (Popper 2002). Second, students are led to the mistaken belief that theories are in need of proving despite the construct of proof not being applicable to science in the first place, because science deals with open systems—such as Nature—while the notion of proof applies only to closed systems of reasoning—such as mathematics and the propositional calculus (Bateson 1979). Thus, the modernist instantiation of schooling practice and games-to-teach—as an embodiment of the schooling mindset—project an aura of axiological neutrality and tacitly reject the idea that our understanding of the world is socially constructed. In doing so, schools perpetuate the miseducation of students.

2.3 Games-to-Learn

Unlike the thinking embodied in games-to-teach, the paradigm of games-to-learn is based on a vastly different set of assumptions and aspirations. Chaps. 4–6 of this book furnish detailed descriptions of three exemplars of games-to-learn located in the domains of social studies, chemistry, and physics, respectively. For this reason, I shall limit myself to a more conceptual explanation of the thinking underlying games-to-learn in this section.

Games-to-learn are founded on a model of inquiry learning articulated by John Dewey. For Dewey, learning is triggered by an interruption to meaningful activity in a person's lifeworld. The interruption leads naturally to contemplation directed to achieving a successful resumption of the activity. For this reason, knowing as inquiry is something that we, as humans, literally *do*, as described in Sect. 2.2.3. Dewey (1938/1991) defines inquiry in the following terms:

> *Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole*. (p. 108, original emphasis)

The inquiry process is characterized by five logically distinct steps: "(i) a felt difficulty; (ii) its location and definition; (iii) suggestion of a possible solution; (iv) development by reasoning of the bearing of the suggestion; and (v) further observation and experiment leading to its acceptance or rejection; that is, the conclusion of belief or disbelief" (Dewey 1909/1991, p. 246). Consequently, knowing is always located within the process of the ever-changing dynamic coupling between an organism and its environment. Separation between a normative or prescriptive logic of inquiry from an empirical or descriptive methodology of inquiry is explicitly rejected (Dewey 1938/1991). The two parts are inherently coupled and part of a functional whole. For a transformation to occur, as part of constructing a practical solution to a problem that is encountered, two distinct kinds of operations are required: (a) existential operations executed in the world that bring about changes in the situation and (b) conceptual operations that arise from thinking and reflecting. As explained by Biesta and Burbules (2003, p. 59), "[w]hat distinguishes inquiry from trial and error is the fact that the transformation of the situation is *controlled* or *directed* by means of reflection or thinking" (original emphasis). Executing a hypothesized solution and observing the consequences of the executed action allow an inference to be made as to whether one's understanding of the situation was indeed warranted. If the empirical feedback is consistent with one's expectation, there is then a concrete basis for making an assertion or claim about the nature of the situation. However, if the expectation is not affirmed, then one's understanding of the situation is clearly suspect. In this manner, a functional correspondence develops between (a) relations between symbols that arise through the mental act of *inferencing*, and (b) the actual connections, or significance, of real-world events that arise by means of *acting* in the world. Because of this, the habituated actions of a person become increasingly tuned to those that yield preferred outcomes in the world. Concurrently, a change in the relationship develops between the symbols—the basis of explicit thinking rooted in language—and gives rise to a new understanding, and hence a new meaning, to the situation at hand. As Dewey (1916/1980) argues, "analysis is ultimately physical and active; … meanings in their logical quality are standpoints, attitudes and methods of behaving toward facts; and … active experimentation is essential to verification" (p. 367).

Based on Dewey's articulation of learning as entailing the process of inquiry, game-based learning curricula instantiate, intentionally and by design, an inquiry process that students must work through. Such curricula are characterized by the periodic occurrence of problems. These problems occasion the sense of a felt difficulty that disrupts the smooth flow of events in the learner's in-game experiential lifeworld. Learners must first try to frame the problem by ascribing to it a certain location and definition. They must then generate, through imaginative thinking, alternative courses of action that might yield a solution. These alternative solution paths must then be critically considered to evaluate which path is the one most likely to produce the desired outcome. Whether the preferred alternative actually gives rise to the desired outcome can only be determined by putting the idea to an empirical test. By executing the action or actions implied by the idea, accompanied by careful observation, an evidence-based justification for a belief about the real world (or otherwise) can be derived. In a nutshell, this cycle of action constitutes the heart of scientific inquiry. In like manner, when learners take the next step by communicating their personal meaning making with other students, with teachers, and with the wider community, they begin to participate as social constructors of meaning in a scientific community of inquiry. In this manner, their thinking, always coupled to their actions, develops into an understanding of the world: an understanding that is laden with significance because it is transactionally coupled to acting in the world. Consequently, learning of this kind is inherently grounded in the world and hence situation specific. As the repertoire of unique experiences grows, distillations from the unique instances become possible through the power of language (as explained in Sect. 2.2.2), allowing the development of categories and classifications, and more abstract modes of thinking and speaking. In this manner, the power of generalization arises primarily via an inductive mode of thinking rather than a deductive one.

Learning with games in the manner described above leads to outcomes different from that of the games-to-teach paradigm. Whereas the latter results in inert knowledge due to being "lost in representations" and an inability to act upon what one knows about, games-to-learn deliberately foster (a) the ability to act in situationally appropriate ways and (b) the construction of meaning by grounding language use in action. The outcome is best described as meaningful learning, unlike the meaningless cognition of machines.[6] Meaningful learning inherently requires students to be deeply engaged in the process of learning. Consequently, the challenge of disengaged students is averted by means of a paradigm shift.

[6]Machines, such as computers, whose "intelligence" is at best artificial can only mimic human cognition in a syntactically driven and semantics-free manner. Thus, inputting "3 × 5" on an electronic calculator will yield the display "15". But the calculator's output is constituted by the numerals "1" followed by "5". This output is very different from how a human usually reads the output: as the *number* 15. A number is a semantically laden notion in the field of arithmetic, but a numeral is (only) a representation of a number. Indeed, multiple numeral systems exist, for example, the Arabic numeral system and the Roman numeral system. Consequently, numerals are *arbitrary representations* of number. There is no single one-to-one mapping between numeral and number. In this sense, numerals are said to be meaningless.

2.4 The Difference and Why It Matters

The fundamental difference between the paradigms of games-to-teach and games-to-learn is broadly mirrored in the distinction between schooling children vis-à-vis educating them. The practice of schooling today is manifested in its discourses, in particular the discourse of knowledge acquisition and that of repetitive drills for practicing skills. Knowledge transmission (so called, but actually the verbalization of knowledge representations) is evidenced by the dominant practice of teacher expository talk and the culture of getting students to complete worksheets correctly to demonstrate that they have adequately mastered the target knowledge and skills. Teachers' pedagogical practices will not change unless society in the broad recognizes the limitations of current schooling outcomes and initiates the necessary steps to shift teachers' professional practice from schooling to educating children and young adults under their care.

Schooling practice is rooted in institutional norms that accord primacy to student achievement evidenced by high test scores aligned to standards-based national examinations and international benchmarking tests. Rooted in an overriding desire for objective comparison across students, across schools, and across nations, curricula are designed in a reductive fashion, and assessments favor narrow closed questions so that assessment outcomes can be claimed to be valid, reliable, and fair. This approach aligns with an epistemology in which knowledge is seen as (i) formal, produced by rigid adherence to a particular research methodology; (ii) intractable, grounded on the assumption that the world is an inert, static entity; (iii) decontextualized, being constructed by researchers who have been able to isolate a phenomenon from its context; (iv) universalistic, by virtue of following strict scientific procedures that yield discoveries applicable to all domains of the world and the universe; (v) reductionistic, focusing on factors that lend themselves readily to measurement; and (vi) one-dimensional, being shaped by the belief that there is one true reality that can be discovered and completely described by adherence to correct research methods (Kincheloe 2008). Armed with this mindset, there is little room for non-orthodox answers to test questions and for answers that may be novel yet still valid. An attitude of intolerance toward interrogation, not only of assessment means but also of ends, has led to a stagnant practice that lauds innovation rhetorically while eschewing change in the name of preserving stability.

A well-known truism in education is that assessment drives learning. The field of educational assessment draws a distinction between content standards and performance standards. The former define essential knowledge, understandings, and skills that should be included in curriculum, while the latter specify "how much" students should know and be able to do (McMillan 2008). This perspective is problematic in at least three respects. First, test performance is not the same as learning. Learning itself is unobservable, and, hence, for assessment purposes, reliance is placed on observable test performance (Maxwell 2009). Consequently, conventional school assessments evaluate only learning *outcomes*;

they do not evaluate learning as such. Learning remains enigmatic and unaccounted for. Thus, Maxwell (2009, p. 267) argues that “[s]tandards that service learning may need to be represented differently from standards for performing a [school] task,” especially in light of the needs of twenty-first-century education. Second, conventional assessment practices, according to McMillan (2008), address the evaluation of products, such as a Web page, and skills, such as reading. Such assessments are carried out because “[t]eachers want to know *how much* students understand before they begin a unit of instruction, *how much* students are progressing in their understanding during instruction, and *how much* students have learned at the end of the unit” (McMillan 2008, p. 6, italics added). The bias toward objectification, quantification, and measurement should be self-evident. However, like learning, understanding is not directly observable. How, then, does one measure some “thing” that is not observable in the first place? Third, McMillan’s assumptions related to assessment reveal a strong cognitive bias. It is limited to three “cognitive levels.” The first level—knowledge—is represented by operations such as retrieving, selecting, naming, and reproducing. The second level—understanding—is represented by operations such as converting, translating, explaining, comparing, and illustrating. The third level—application—is represented by operations such as analysis, synthesis, and transfer. It should be evident that McMillan’s language is rooted in Bloom’s taxonomy of educational objectives in the cognitive domain. The weaknesses of this classification, as appropriated into the space of instructional design, have already been critiqued in Sect. 2.2.3.

Given the dominant forms of assessment described above and the truism that assessment drives learning, teachers naturally engage in instructional practices that attempt to bridge the gap between content and performance standards on the one hand and conventional modes of assessment on the other. Broadfoot (2009, p. vii) laments that “despite a growing recognition of the limitations of a scientific approach to assessment, the twenty-first century is nevertheless finding it hard to escape from the assessment thinking and practices that were characteristic of the twentieth century.” The regrettable outcome of conventional teaching and schooling practice is thus one of inert knowledge and of students not being able to think critically, systematically, and creatively for themselves.

In Whitehead’s (1929) seminal book, *The Aims of Education*, he describes a well-informed man with scraps of information as “the most useless bore on God’s earth” (p. 1). He appeals thus to teachers:

> With good discipline, it is always possible to pump in the minds of a class a certain quantity of inert knowledge. You take a text-book and make them learn it. So far, so good. The child then knows how to solve a quadratic equation. But what is the point of teaching a child to solve a quadratic equation? There is a traditional answer to this question. The mind is an instrument, you first sharpen it, and then use it; the acquisition of the power of solving a quadratic equation is part of the process of sharpening the mind. (p. 6)

Similar to other historical attempts to teach Latin and computer programming because they supposedly “sharpen the mind,” Whitehead denounces the conception of mind as an instrument in need of sharpening as "one of the most fatal, erroneous, and dangerous conceptions ever introduced in the theory of education" because:

> The mind is never passive; it is a perpetual activity, delicate, receptive, responsive to stimulus. You cannot postpone its life until you have sharpened it. Whatever interest attaches to your subject-matter must be evoked here and now; … whatever possibilities of mental life your teaching should impart, must be exhibited here and now. This is the golden rule of education, and a very difficult rule to follow. (p. 6)

Thus, Whitehead argues against the notion that schooling constitutes a preparation for life in some non-determinate future and in favor of making education relevant to the life of the child in the here and now. He asserts that we must "eradicate the fatal disconnection of subjects which kills the vitality of our modern curriculum. There is only one subject-matter for education, and that is Life in all its manifestations. Instead of this single unity, we offer children—Algebra, from which nothing follows; Geometry, from which nothing follows; Science, from which nothing follows" (pp. 6–7). A curriculum from which nothing follows with respect to the life of the child is misdirected at best. Perhaps educators today would be well served to pay heed to Whitehead's words of wisdom.

Like Whitehead, Dewey was much concerned with the disconnect between curriculum subject matter and the life of the child. In his pedagogic creed, Dewey (1897/2004) argues that "[t]he child's own instincts and powers furnish the material and give the starting-point for all education. Save as the efforts of the educator connect with some activity which the child is carrying on of his own initiative independent of the educator, education becomes reduced to a pressure from without" (pp. 17–18). He further insists that the "school must represent present life—life as real and vital to the child as that which he carries on in the home, the neighborhood, or on the playground" because "education is "a process of living and not a preparation for future living" (p. 19). For Dewey, schooling as a modern-day practice fails because it neglects the fundamental principle of the school as a form of community life, creating instead an alternative form of institutionalized social life.

With respect to teaching science, Dewey (1897/2004) observed:

> One of the greatest difficulties in the present teaching of science is that the material is presented in purely objective form…. In reality, science is of value because it gives the ability to interpret and control the experience already had. (p. 21)

However, to learn science effectively, meaningful activity must be placed at the center of student learning. The active side must precede the passive in the development of the child because:

> Ideas result from action and devolve for the sake of the better control of action…. [R]eason is primarily the law of order or effective action. To attempt to develop the reasoning power, the power of judgment, without reference to the selection and arrangement of means of action, is the fundamental fallacy in our present methods of dealing with this matter. As a result we present the child with arbitrary symbols. (p. 22)

I have already highlighted the deep difference between learning *about* swimming and learning swimming in Sect. 2.2.1. Here, I wish to add that the modes of instruction implied by each goal are also vastly different. Traditional modes of instruction entailing content transmission and worksheet completion may well yield excellent test performance on an *about*-swimming curriculum. However, it will not produce children who can swim competently. Clearly, to produce students who can swim, a coaching approach requiring students to learn to swim (typically) in a swimming pool is vital. The issue that needs to be grasped here is that the coaching approach does not imply sole reliance upon the actions of learning. Rather, as the foregoing excerpt from Dewey indicates, the challenge is to develop the coupling between the action and the thinking, or reflecting, upon that action. Consequently, there are three conceptual parts to learning: acting, thinking, and the couple constituted by acting–thinking. Traditional schooling focuses almost exclusively upon the cognitive and representational aspects related to thinking. By omitting acting and acting–thinking, it yields a non-performative outcome: Students are unable to do anything useful and personally meaningful in their own lifeworld. Consequently, generations of students may become schooled, but, educationally, they end up as generations lost. Society pays a high price for this mistake.

From the foregoing, I hope to have made the case why clearly understanding the difference between games-to-teach and games-to-learn, together with what each implies and entails when acted upon, is vitally important. As educators, it behoves us to restore the missing component of action back into educational practice so that the acting–thinking relation can be made the centerpiece of a *bona fide* and revamped practice. Consider what twenty-first-century education might look like if a question like the following, suggested by Postman (1995), were to appear in examinations:

> Describe five of the most significant errors scholars have made in (biology, physics, history, etc.). Indicate why they are errors, who made them, and what persons are mainly responsible for correcting them. You may receive extra credit if you can describe an error that was made by the error corrector. You will receive extra extra credit if you can suggest a possible error in our current thinking about (biology, physics, history, etc.). And you will receive extra extra extra credit if you can indicate a possible error in some strongly held belief that currently resides in your mind. (p. 128)

It is most unlikely that any student can respond to the question competently and intelligently if she or he has not developed a working *competence* with the subject domain in question. Mere "head knowledge" would not suffice to demonstrate subject competence. Memorization, as a learning strategy, would not yield any dividends. In the next chapter, therefore, I argue for pedagogy that is based on a theory of performance so that the vision of game-based learning may be realized.

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Chapter 3
Theory of Game-Based Learning as Performance

Chapter 2 addressed differences between games-to-learn and games-to-teach by interrogating the underlying bases—epistemological, ontological, praxiological, and axiological—of these two approaches to the design and use of educational games in schools. In this chapter, I highlight weaknesses inherent to the dominant view of learning construed in terms of the psychological theory of human information processing. I suggest instead an alternative framing based on the philosophy of pragmatism. I then articulate the Performance–Play–Dialog model as a specific theory of game-based learning grounded in the construct of human performance instantiated through game play and dialogic engagement with others. I close the chapter by revisiting how people learn in relation to learning as becoming and the development of personal identity.

3.1 How People Learn

In a seminal paper published in 2007, Thomas and Brown suggest that games and virtual worlds allow play and learning to merge, thereby providing a fundamentally different way to think about learning—characterized as "learning to be"—compared with traditional modes of instruction that emphasize "learning about." They argue in particular that massively multiplayer online games, which combine player-created avatars, game mechanics, and a complex social, economic, and cultural network that surrounds the activity of game play, enable a unique form of learning that "produces new dispositional stances, exercises the play of imagination, and provides for a complex sense of agency" (Thomas and Brown 2007, p. 155). This theoretical perspective allows us to move beyond the traditional emphasis on "learning about"—the legacy of a Kantian and Cartesian heritage that detaches knowing from the material world, including the body, and considers

Y.S. Chee, *Games-To-Teach or Games-To-Learn*,
Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_3

knowledge structures to be abstractions from experience, including the emotions (Roth 2006)—and to begin to acknowledge and account for the reasons underlying human actions and the personal agency that drives human investment in the learning process.

I this chapter, I put forward what it might mean to respond to Thomas and Brown's construction of learning as "learning to be." I anchor my approach upon Dewey's perspective of fostering learning *as* inquiry (Biesta and Burbules 2003; Dewey 1938/1991). Before embarking on this theory building, however, I first examine why the dominant psychological theory of human information processing, from which an emphasis on "learning about" arises, is weak and found wanting.

3.1.1 Inadequacy of Human Information Processing

People commonly believe that cognitive processes such as thinking, reasoning, and problem solving arise from human information processing (Bransford et al. 2000). This belief is grounded in cognitivism (Still and Costall 1991), a theoretical perspective with roots in the mid-1950s that conceived the human mind as a mental computational engine. Based on the metaphor of the computer processor, human cognition is thought of as following an input–process–output model. It assumes that cognitive processes entail receiving information inputs, including sensory inputs, processing those inputs, and outputting the information that results from the processing back into the environment. On this account, cognitive processing entails the mental processes of recognition and recall from memory, where memory is construed as a form of information storage.

Arising from the work of Newell and Simon (Newell 1980; Newell and Simon 1972, 1976), mind is hypothesized as a physical symbol system that possesses the computational power of a universal Turing machine; that is, it can compute anything that is in principle computable. Consequently, the study of human cognition took a computational turn (Pylyshyn 1984) and computer models of mind became popular (Boden 1988). As Holder (1995) points out, the commitment to computation cast thinking as the deliberate manipulation of mental representations. In addition, thinking-as-computation focuses primarily on the truth value of symbolically expressed propositions. Inadvertently, perhaps, the model of human thinking became governed by formal reasoning in the propositional calculus.

The seeds of a mechanistic understanding of cognition can be traced to two significant historical developments. First, the development of the physical sciences from the seventeenth century and the subsequent dawn of the Enlightenment era led to the rise of modernity and the norms of a new scientific method predicated on empirical inquiry and causal explanations rooted in material bases. Second, epistemology as a distinct philosophical discipline was established, based on the belief that it must be a foundational enterprise; that is, a rigorous discipline prior to any science so that epistemology could be used to check the truth claims made by any alleged science. Unfortunately, the thinking described here is itself rooted in two fundamental misassumptions. First, it assumes the existence of an "inner" mental world and a separate "outer" physical reality. Second, it assumes that "true knowledge" is the correct representation of that independent "outer" reality. Both assumptions are flawed.

The first assumption of an "inner" mental world and an "outer" physical reality gives rise to ontological dualism and the classical mind–body problem. It reflects a "reflexive turn," attributable to Descartes, where the seeker after science is directed "within," to the putative "contents" of his own mind (Taylor 1995a). The problem of ontological dualism has already been addressed at length in Sect. 2.2.2. Suffice to add here that attempts to date by neuroscientists and philosophers alike to discover the material basis of mind have proven fruitless (Churchland 1988; Searle 1984). In an incisive critique of cognitive science in general and neurophilosophy in particular, Coulter and Sharrock (2007) argue that adherence to materialist and dualist assumptions in respect of mind and brain arises from errors of conceptualization deeply intertwined with how everyday language is used. They argue that the claim that things are identical with what they are made of—the materialist assumption—is not a result of science but rather is an idea inherited from the substance metaphysics of Aristotle. Consequently, it is not the part of neurophysiology and brain states to inform us about peoples' intentions, motives, conventional ways of doing things, the grammar of their languages, and their attitudes to things because such phenomena arise out of *social* forms of life and discourse that bear no necessary relation to neurophysiology (Coulter 2008). In similar vein, Munz (1999) argues that explicit human consciousness is inherently linguistically colored, and it cannot be causally linked to underlying neuronal states. The neurons are always silent; that is, they are non-semantic entities. To think otherwise is to succumb to the melioristic fallacy: the misplaced ascription of psychological attributes to neurophysiological phenomena (Bennett et al. 2007). Consequently, looking solely to the brain for an explanation of the mind is erroneous and misguided at best.

The second assumption that "true knowledge" is the correct representation of an independent "outer" reality is problematic because it assumes that mind is a mirror of nature (Gergen 1999; Rorty 1979). Consequently, the presumption is made that there is a one-to-one correspondence between the "in here" world of human subjectivity and the "out there" world of physical objects. Words and language that we use to describe the world and events in the world are thus assumed to have a direct correspondence with happenings in the world. However, this assumption is palpably false. Two witnesses, in close proximity to each other, can give significantly different accounts of a car accident that has taken place before their very eyes. The misplaced "correspondence theory of language" (Gergen 1999), which assumes a one-to-one correspondence between language-based description and real-world event, erroneously assumes that a human knower can stand outside of and apart from the world and account for what takes place in the world in an entirely objective way. Unfortunately, this is not possible. Classical epistemology approaches the problem in terms of the (independent) knower and the (objective) known. However, as Dewey and Bentley (1949/1991) have shown, we must overcome this epistemological error by approaching the problem in terms of *knowing*, an in-the-world process, and the known. As human observers, we cannot detach ourselves from the world to view it from an objective third-person standpoint. Rather, we are born *into* the world, and our observations of the world are inescapably rooted in our experiences *in* the world. Consequently, we are always *part of* the world. There is no possibility of observing the world "objectively."

Based on the foregoing arguments, it should be evident that the theory of human information processing, predicated upon computational mechanism acting upon knowledge representations, is misleading at best. Given that the symbolic representations processed by a computer have no inherent meaning in and of themselves and that the correspondence theory of language is untenable, it follows that the theory of human information processing is an inherently "meaningless" theory of cognition; that is, it is meaning-free. A cognitive theory that has no capacity for dealing with semantics in the life world of human experience cannot be a viable theory of human cognition.

3.1.2 Approach of Pragmatism

Given the conundrum that arises out of human information processing, we need to approach our understanding of human cognition differently. We find such an approach in the pragmatic philosophy of Peirce, James, and Dewey. The pragmatist creed is exemplified in Peirce's maxim: "Consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then our conception of these effects is the whole of the object" (Peirce 1878/1992, p. 132). Given its emphasis on effects with practical bearings, pragmatism can be understood as emerging out of a theory of *meaning* because the meaning or significance of any event is intimately tied to the possible consequences that arise from human actions in the real world. If the consequences of two conceptions are identical to an individual, then their meaning must also be identical (Garrison and Neiman 2003). From an educational perspective, then, a central aim is to develop students' capacity for effective action. James and Dewey argue that human needs, interests, and purposes are pre-eminent in thought and action. James insists: "My thinking is first and last and always for the sake of my doing" (James 1890/2007a, p. 333).

In order to ground mental functioning in biological functioning, James appeals to the biological conception of psyche and the theoretical construct of *habit*. He argues that "[t]he great thing, then, in education is to *make our nervous system our ally instead of our enemy … For this we must make automatic and habitual, as early as possible, as many useful actions as we can …* The more of the details of our daily life we can hand over to the effortless custody of automatism, the more our higher powers of mind will be set free for their own proper work"

(James 1890/2007b, p. 122). In short, learning should make useful actions habitual so that we do not need to think afresh about what to do after we have learned to deal effectively with a certain type of problem situation. Similarly, Dewey (1995) argued for the development of fundamental dispositions, where dispositions are an important category of habits.

For both James and Dewey, thinking is a process that emerges from and is continuously controlled by non-cognitive levels of experience, including emotion, habit, and imagination (Holder 1995). They explicitly reject cognitivistic models of thinking because such models over-strongly foreground "mental structures" at the expense of non-cognitivistic aspects of experience, including habits, values, and beliefs. Peirce (1878/1992) argues: "Our beliefs guide our desires and shape our actions. . . The feeling of believing is a more or less sure indication of there being established in our nature some habit which will determine our actions" (p. 114).

From the perspective of pragmatism, thinking is a process inextricably situated in experience. Dewey (1925/1988) argues that experience has as its basic pattern a two-way *transaction* between an organism and its environment; that is, the relation is inter-dependent and one of mutual coconstitution. Transactions occur on multiple inter-dependent levels, including the social and physical levels. Experience involves embeddedness in a situational context that has structural complexity. Structural complexity, in turn, invokes the qualitatively immediate features of experience including emotions, feelings, and attitudes. Consequently, we are always in experience. As pointed out by Elkjaer (2009), this theoretical framing of experience differs fundamentally from Kolb's (1984) conventional construction of experience as a resource drawn upon for the purpose of learning. Dewey distinguished between the "foreground" and the "background" in experience. The foreground is that which holds our attention. The background is that part of the situation that provides a presupposed and unquestioned qualitative immediacy to our thinking. The foreground always presupposes the background and vice versa. Hence, every act of thinking is always coupled with an implicit context in which the thinking occurs. Within the unity of this transactional act, meanings emerge through the person's precognitive activities and feelings (Garrison 1998).

Dewey argues that thinking arises in a feeling of perplexity in the non-cognitive background or embodied experience (Johnson 1987). When thinking is activated, the qualitative immediacy of experience is transformed from the level of feeling to one where possibilities and connections are recognized. These possibilities and connections are exploited at the cognitive level for use as ideas and action plans. Even as the cognitive level processes take place, substantial portions of the non-cognitive dimensions of experience are retained. They serve to regulate the thinking experience and to provide standards of *valuation* that serve as the habitual norms by which humans exercise judgments. Every experience is qualitatively pervaded with emotion, which constitutes the basis of attitudes toward things. Thus, emotion provides a primary interpretative scheme through which all sense-making activity is filtered and "colors" the meanings of the particular constituents of a situation. Unlike a cognitivistic interpretation, emotion is not perceived as an inhibiting factor or a source of bias; instead, it plays a constructive role in the thinking process. Based on Dewey's account, the emergence of thinking does not entail a break from the continuity of experience. Rather, it represents the emergence of a new organization of experience (Holder 1995). Consequently, it is the unity of the person that is always engaged in thinking, and the Gordian knot of mind-body dualism is severed.

For Dewey, inquiry, or deep thinking, begins in doubt and concludes when the stimulus of doubt is removed (see Sect. 2.3). He argues that educational aims must be capable of translation into teaching methods that fit the activities of those who receive instruction. He insists that students must be treated as participants in life and not as spectators of life, the difference being that participants have direct care and concern for their own future, while spectators do not. As participants, they are inclined to act to ensure the best possible outcomes for themselves. Hence, curriculum design must respect and incorporate the inherent personal interests and agency of learners. Dewey also argues that education should be a process of forming fundamental dispositions—both intellectual and emotional—toward nature and toward others (Dewey 1916/1980). It should free human intelligence in ways that allow the reconstruction of physical and social environments, including the construction of selves. For Dewey, intelligence is as much about creative imagination and passion as it is about cognition. Educating *eros*, a passionate desire for what is valuable and the development of a creative imagination capable of envisioning improved future possibilities, is as important as mastering facts and the principles of reasoning and logic. As Garrison (1998) argues, this outcome cannot be achieved without thoroughly critiquing existing social customs and forms of thinking related to schooling so that the "thoughtless rehearsal of ancestral prejudice" (Dewey 1908/2008, pp. 126–127) may be avoided.

3.1.3 Learning from a Social Standpoint

To deal with the theoretical inadmissibility of "meaning-less cognition" (Sect. 3.1.1) and to escape the dichotomy of idealism versus empiricism, I turned to pragmatism as a naturalistic approach to understanding how people learn. Building on pragmatism, I now further recontextualize how people learn in terms of the construction of their personal identity through the process of becoming (Rogers 1961; Semetsky 2006). From this perspective, learning is no longer restrictively conceived of in rationalistic, mind-centric terms. Rather, it is reframed as a *person*-centric, developmental, and transactional process. Jarvis (2009) captures this idea elegantly: "Learning to be a person in society: Learning to be me." Put differently, we are not born as ready-made adults into the world but must learn to become who we are (as an ongoing process). This theory of learning is thus one of *being* and *becoming*. It allows us to construct an account of learning that is meaning-laden.

Dewey (1925/1988) argues that "[m]eanings do not come into being without language, and language implies two selves involved in a conjoint shared undertaking" (p. 226). Thus, meanings emerge when we render something common between two or more centers of action through the reciprocal coordination of behavior (Garrison 1998). Focusing on the development of understanding between two or more selves places us within the domain of social and cultural theory. In what follows, I draw on the social theories of Mead and Bourdieu to ground my theory of game-based learning on the construct of performance, accomplished through the activities of play and dialog.

3.1.3.1 Mead's Theory of Mind, Self, and Society

Mead (1934) developed a theory of self that is faithful to what is known from biology and sociology. His theory is completely social in orientation. It views social interaction (transactions in pragmatic terminology) as the chief organizing principle underlying human behavior. Mind is not conceived of as something that resides in the physical brain. Instead, the social mind is constituted in *behavior* and manifested through internalized communication that is always social in nature. From Mead's perspective, then, we are not *born* human but rather (learn to) *become* human. Learning to become human implies that each person is a historically and socially situated unique self (Allan 2005).

According to Mead, the self is a social object whose meaning emerges through successive role-taking experiences in the course of interacting with others. Its meaning will tend to change as the person's interactions change. Consequently, the self is a social entity constituted through ongoing social interaction and production. Society and thinking are made possible reciprocally via the existence of self. The self, on the one hand, and society and thinking, on the other, are thus related dialectically. Furthermore, what society is and the influence that society has on people's meaning making arise through face-to-face interactions that involve the use of symbolic and natural language. Language as used thus becomes a repository of *social* experiences. It expresses and preserves social and cultural events, experiences, and pragmatic meanings. It thereby comes to be a social entity that exists "outside of" individuals. When we use language to understand our *own* experiences, those experiences become social as well.

The self, based on Mead's theorization, is a constructed *perspective* divorced from the constraints of time and place. It is a symbolic platform from which we view our *own* behaviors as if someone else were performing them. *Role-taking* is the crucial process through which we learn to place our self in the position of another in order to think about our own self. This process requires the individual to adopt a separate perspective and to activate personal meaning-making processes in reflecting upon oneself.

Mead (1982) further theorized that the genesis of self occurs through three stages of role-taking: play, game, and the generalized other. He articulates these stages in the context of a child's enculturation into society. During the play stage, the child takes the role, or assumes the perspective, of a certain significant other. During this stage, children must literally play at being some significant other, such as the child's mother, in order to see themselves. This act represents the genesis of an *objective stance* that allows a child to get outside of herself in order to watch the self, as if on a stage. During the game stage, the child begins to take the perspective of several others and learns to take into account the rules, or sets of responses different attitudes and behaviors bring out, of society. During this stage, the child can take on the role of several individuals, but they remain as separate individuals. As the child develops the ability to use abstract language and concepts, she becomes able to think in terms of more general or abstract others such that specific people are no longer involved. Rather, the child is able to see herself through the eyes of some generalized other. This generalized other refers to sets of attitudes that an individual can take toward oneself, and it represents the general attitude or perspective of a community. In this manner, through the generalized other, the community begins to exercise control over the conduct of individual members.

The construct of the generalized other allows Mead to frame the social mind as an internalized conversation between two aspects of the singular self: the acting self, referred to as the "I," and the observing self, referred to as the "Me." "I" represents the seat of impulse: the part of the self that is unsolicited and spontaneous in behavior. "Me" represents the perspective assumed when, as individuals, we view and analyze our own behaviors. Possessing a sense of selfhood entails a reflexive, internal dialog between "I" and "Me." The "I" is the subject, and the "Me" is the object. What "I" do, I do to the "Me" (Allan 2005).

For Mead, then, the self is neither an individual nor a psychological construct. Rather, it is constructed through language acquisition and role-taking in social interactions. The "Me" presents to the individual the perspectives of society-at-large—the meanings and likely repercussions of our actions—while the "I" presents our impulses and drives to act. These two elements of the self converse until a course of action is decided upon. The individual cannot know the action of the "I" until it is executed and then experienced. Hence, it is possible for the "I" to take an action that the "Me," from its social standpoint, would not consider acceptable. These two elements of the self are reflexively and mutually aware, and they continually converse back and forth. Self is thus constituted by this social, reflexive, dialogic, and ongoing internal communication process, as part of an unfolding trajectory of *becoming* a person.

3.1.3.2 Bourdieu's Theory of Practical Knowledge and Habitus

In the context of learning, we are naturally concerned with the development of specific domain expertise by individuals engaged in professional practice and the professional identity that emerges from their personal trajectory of becoming. Bourdieu—sociologist, anthropologist, and philosopher—was particularly concerned with the false dichotomy between theory and practice that continues to dominate Western thinking (see also Sect. 2.2.3). Such thinking has a tendency to neglect and undervalue the kind of non-theoretical knowledge implicit in practical skills. The theory–practice dichotomy further encourages the view that practice arises from the application of theory, based on a form of rule following. These entailments are problematic, and they hinder the development of a deep understanding of professional practice.

Bourdieu confronted the widely presumed difference between practical and theoretical knowledge by drawing upon the metaphor of sports games to convey his sense of what is entailed in practical, social life. Games, Bourdieu argued, are "a central part of the activity by which forms of life are constituted and transformed" (Calhoun 2003, p. 275). No game can be understood simply by grasping the theoretical rules that define it. To play a game effectively, it is necessary not just to follow rules, but also to have a "sense" of the game and a sense of how to play it. Actions in game play do not consist of simple, conscious decisions that are quickly executed. A player's actual shots, as in basketball, are real-time improvisations irreducible to theoretical rules. *Habitus* is the capacity of each player to improvise the next shot and the next move. We are not born with a habitus. It is something that we learn through repetition, and it is something we come to know intuitively in our bodies. In practice, human activity involves a combination of discursive awareness and unconscious skill. The rules of each game are constraints on players and the ways in which players get things done. Although players are obliged to treat rules as fixed and unchanging, they are in fact historically produced and subject to continual change.

In his *Outline of a Theory of Practice*, Bourdieu (1977, p. 78) refers to habitus as "the durably installed generative principle of regulated improvisations" that produces practices. It appears as each individual's characteristic set of *dispositions* for action (cf. Section 3.1.2). Habitus is the meeting point between institutions and bodies. It is the way in which each person, as a biological being, connects with the sociocultural order such that the various games of life retain their meaning and keep being played. Habitus is thus not only a personal achievement but also a social and collective achievement that develops each individual's habitual orientations to action.

From the perspective of *learning as becoming*, then, the educator's goal is to help students develop enactive expertise that is deeply embodied, highly adaptive, and closely aligned to professional practice. Such expertise is grounded in values, dispositions, and habits of action that arise through influences exerted by students' learning and cultural trajectories. The rules and structures of perception related to a particular habitus are inscribed on, and in, individuals as if they are "human nature" or "civilized behavior" (Webb et al. 2002). However, these rules are not self-interpreting. As Taylor (1995b) argues, without a sense of what they are about and an affinity to their spirit, they remain dead letters or become a travesty in practice. Rules operate in our lives as *patterns* of reasons for action. They lie essentially *in* practice and do not constitute causal regularities. Rules animate practice. They are not some formulation behind it, inscribed in our thoughts, brains, or genes. Practice involves continual interpretation and reinterpretation of what the rules might mean. Rules can only function in our lives along with an inarticulate sense "encoded" in the body. It is this habitus that "activates" the rules and brings professional practice to life. Learning conceived as a trajectory of becoming oriented toward professional participation necessarily entails the development of habitus.

3.2 The Performance–Play–Dialog (PPD) Model

In the previous section, I made the connection between learning and social theory to build on the pragmatist approach to education. This conceptual groundwork allows me now to construct a theoretical model of game-based learning in terms of learning to be some kind of person in society through the process of becoming.

Immersive computer and video games have the unique affordance of allowing players to learn in the *first person* rather than the customary *third-person* perspective that focuses on learning *about* subject matter. Role-playing games, for example, allow students to enact role-taking, in the sense articulated by Mead, and to construct themselves, and thereby their identity, via the I–Me dialectic. These environments thus provide an ideal context within which to enact learning in terms of the pedagogical principle of becoming.

Central to my design for learning (Kalantzis and Cope 2005) is the Performance–Play–Dialog (PPD) model, which is shown in Fig. 3.1. The figure shows that the central goal of learning is the development of enactive capacities for *performance* with respect to valuable domains of practice, for example, a professional chemist or an active citizen. The overarching capacity for performance is developed, in turn, through the learner's participation in game *play* with other players coupled with teacher-facilitated *dialog* in the classroom, which is based on game play as it unfolds. Game play entails acting, conversing, and making decisions in an immersive game space. Dialog requires students to evaluate and reflect on their choices and actions—on their own and with their peers—taken in the course of game play. The dimension of time is indicated by the progression of the student over the course of game play; it is depicted by the figure of the student (which becomes more faint over time) moving at a 60º angle toward the top right of the figure. It is argued that, through this process, students develop a deep enactive understanding of the domain as well as their self-identity with respect to that domain. The "true" test of a student's learning will become manifest only in the future when the student faces authentic problem situations related to the domain. The depiction of the PPD model shown in Fig. 3.1 relates in particular to the Statecraft X curriculum, which is described in Chap. 4. Because *Statecraft X* is a multiplayer mobile game played on Apple iPhones, the ongoing state of the game world is maintained by a game server. For this reason, the persistent game world is depicted as a "game cloud." In the subsections that follow, I unpack the three central constructs of the model: performance, play, and dialog.

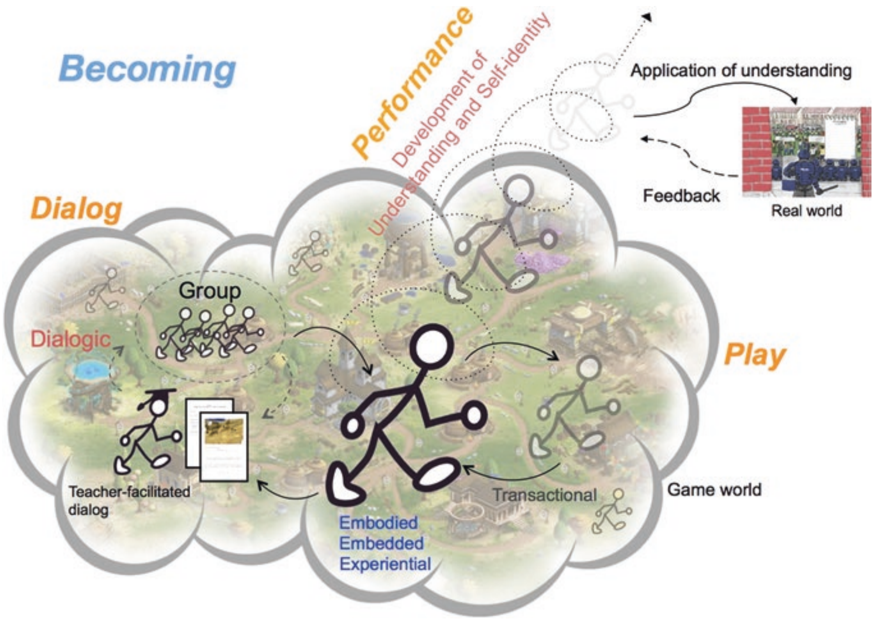

Fig. 3.1 The Performance–Play–Dialog model of game-based learning

3.2.1 Performance

The construct of performance arises from the domains of performance theory and performance studies (Bell 2008; Carlson 2004; Schechner 2006). Bell (2008) argues that performance has three key characteristics. First, it is *constitutive*; that is, it is established, created, and given form through enactment. Performance is constitutive of identity because implicit and explicit claims about that which is valued by human actors as well as how they ought to act are made manifest through performance. Thus, individuals are inscribed and authored through performance. Second, performance is *epistemic*; that is, performance is a way through which human actors come to know themselves, know others, and know the world. Consistent with the kind of knowing articulated by Bourdieu's notion of habitus, performative knowing encompasses "body knowledge" or "somatic thinking"—a way of knowing the world that involves all our senses, emphasizing immediacy and direct involvement. Third, performance is *critical*; that is, it provides a means for staking claims about knowledge and the creation of knowledge. All performance can be approached in terms of faking, making, breaking, and staking. Thus, performance holds possibilities to imitate a life world, to create a life world, to transform a life world, and to stake claims about that life world.

From the perspective of the individual performer, performance is deeply *reflexive*. It implies not just the doing or even redoing of actions, but also a *self-consciousness* about that doing and redoing on the part of the performer. According to Carlson (2004), the difference between doing and performing lies “not in the frame of theater versus real life but in an attitude—we may do actions unthinkingly, but when we think about them, this brings in a consciousness that gives them the quality of performance” (p. 4). Consequently, as Baumann (1989) asserts, all performance involves consciousness of *doubleness*, according to which the actual execution of an action is placed in mental comparison with a potential, ideal, or remembered original model of that action. Performance is always performance *for* someone, an audience that recognizes and validates it as a performance even when that audience is the self. Performance thus involves a kind of inner dialog with the performer herself, a framing that is consistent with Mead’s dialogic interaction between the first person “I” and the third person “Me” (cf. Section 3.1.3.1).

Aligned with Dewey’s pragmatic stance, performance entails living, experiencing, and acting in the here and now. Through performance, performers wrestle with human experience as a lived, always dynamic process, and they develop participatory and embodied ways of knowing and being. The experiencing of the performer is made available for contemplation, thereby providing opportunities to *think* over as well as to think about *differently*.

In sum, performance may be understood as (1) both a process, by virtue of being enactive, communicative, and transactional, as well as a product, by virtue of yielding observable events, (2) productive and purposeful, subsuming intellectual inquiry, cultural memory, participatory ritual, and social commentary, and (3) traditional and transformative, by virtue of always making reference to former ways of doing, acting, seeing, and believing, and thus providing the potential for critiquing the *status quo*. Through performance, human actors develop new ways of seeing and understanding the world and understanding themselves in relation to the world. By this means, they develop a part of their self-identity. The construction of an expansive yet coherent worldview, coupled with the agency to act upon that understanding, is central to learning that is engaging and empowering.

3.2.2 Play

The study of play can be traced back to early writings by Huizinga (1938/1955) and Caillois (1958/2001). Huizinga identified the characteristics of play as (1) voluntary, (2) stepping out of ordinary life into a temporary sphere of activity that absorbs the player intensely and utterly, (3) creating its own limits of time and place, (4) producing no material gains, (5) creating its own fixed rules, and (6) promoting secrecy and social groups. Caillois proposed a taxonomy of games comprising four categories: agon (competitive games), alea (games of chance), mimicry (simulation games), and ilynx (games that create vertigo). He defined the nature of play as (1) free, (2) separate, (3) uncertain, (4) unproductive, (5) regulated, and (6) fictive, with the last two characteristics tending to exclude one another.

Common to both characterizations is the idea that play involves stepping into a "magic circle" (Klabbers 2006) where disbelief is suspended and a new form of reality, which may be temporary, applies. Stepping into the "magic circle" entails taking on a new role, consistent with Mead's claims about the social nature of learning, and this role-taking is typically realized in digital games through role-playing. Sutton-Smith (cited in Turner 1982) suggests that play spaces can be productive for learning because they are places of anti-structure (Turner 1969) that afford the exploration and construction of *new* forms of culture. Sutton-Smith argues: "The normative structure represents the working equilibrium, the "anti-structure" represents the latent system of potential alternatives from which novelty will arise when contingencies in the normative system require it. We might more correctly call this second system the *protocultural* system because it is the precursor of innovative normative forms. It is the source of new culture" (Turner 1982, p. 28). From this perspective, sites of play may be designed and constructed as performance borders and margins that instigate learner transformation by provoking the re-evaluation and reconstruction of understanding and identity, accomplished by breaking, remaking, and staking afresh. As Van Gennep (1960) argues, such experiences are akin to rites of passage that entail separation, transition, and reincorporation, usually to a new community and its associated practices.

Rites of passage are said to be *liminal* because they represent a transitional process that is "betwixt and between two worlds." They are characterized by heightened emotions, the suspension of rules of normal life and time, and the centralization of that which is usually marginal. Liminal activities are inherently anti-structure in nature, and liminal situations provide a space removed from normal daily activity for members of a culture to "think about how they think in propositions that are not *in* cultural codes but *about* them" (Turner 1969, p. 22). This context creates the potential for deeply personal and transformative learning to occur. The realm of play thus serves as the crucible in which "responsible" action for the "real" world is seeded, nurtured, and developed into significant new forms. Play, as a rite of passage, fulfills the crucial task of "inculcating a society's rules and values to those who are to become its full-fledged members," (Bell 2008, pp. 123–124) and the crux of learning and transformation arises through performance.

3.2.3 Dialog

Bakhtin (1981, 1986) originated the concepts of dialog and dialogism, and these ideas are central to his writings. Emerson and Holquist, in the Glossary to Bakhtin's *The Dialogic Imagination*, describe dialogism as the characteristic epistemological mode of a world that is dominated by heteroglossia. In such a world, meaning arises only as part of a greater whole. Socially constructed meanings are in constant interaction, and all meanings have the potential of conditioning yet other meanings.

For Bakhtin, dialog is not constituted merely by words or in talking. Apart from being epistemological, dialog is also ontological: It constitutes a way of life. Dialog expresses a fundamental orientation to an *other* and a desire to understand and be understood in relation to this *other*. It is fundamental to a way of life that is changeable rather than fixed and one that is open and tentative rather than authoritative (Shields 2007). It should be noted that dialog differs significantly from *discussion*, a word whose root is more closely related to the idea of conducting a judicial examination (Senge 1990) and subsequently reaching some form of agreement based upon rationality and reason. Entering into dialog entails taking a stance toward one or more *others*. Dialog is the means through which we develop openness to others different from ourselves and relate to people and ideas that remain separate and distinct from our own. It is the means through which new ideas come into being.

Although Bakhtin uses the word *truth* frequently, he does so in the sense of the Russian *pravda*, truth as lived, rather than the Russian *istina*, truth as fact (Sullivan 2012). For Bakhtin, our reality and other equally valid and distinct realities of others comprise a more complete "truth" than can otherwise be known. All ideas and positions should therefore be placed out in the open in order for deep dialog and understanding to be possible and for "truth" to be determined: not *the* truth, but a more complete one. Thus, Bakhtin does not deal with fixed, irrevocable, and universal Truth that is denoted with a capital "T." Instead, he pursues the testing of an idea, *a* truth, to elicit something of value as a person interacts dialogically with it. Truth, as understood by Bakhtin, is collective. It can never reside in the heart or mind of a single person but only in a community's temporary understanding of some phenomenon (Shields 2007).

In classroom contexts, the aim of dialog is to help students achieve a more expansive comprehension rather than to provide a single explanation. Bakhtin (1986) asserts: "With *explanation* there is only one consciousness, one subject; with *comprehension* there are two consciousnesses and two subjects. There can be no dialogic relationship with an object, and therefore explanation has no dialogic aspects. ... Understanding is always dialogic to some degree" (p. 111).

The notions of utterance and addressivity are central to Bakhtin's construction of dialog. Bakhtin (1986, p. 67) regards the utterance as "a real unit of speech communication." An essential marker of the utterance is its quality of being directed at someone: that is, its addressivity. An utterance has both an author and an addressee who may be a copresent interlocutor in dialog or an indefinite unconcretized *other*. The composition and style of an utterance depend on those to whom the utterance is addressed, how the speaker senses and imagines his addressees, and the force of their effect on the utterance. In addition, in dialog, the speaker always tries to anticipate the addressee's response in the very act of constructing his utterance, thus giving rise to an ongoing transaction between speaker and addressee that is evidenced by an utterance chain (Baxter and Montgomery 1996).

Utterances, as speech acts, are always performative in nature (Austin 1975; Searle 1970). They involve a complex layering of the previous usages of words that are applied within the current context and result in a plurality of "voices." From Bakhtin's perspective, a voice refers to a speaking personality, a speaking consciousness. A voice has its own timbre and overtones, and it always has a will or desire behind it. Indeed, "[t]he word in language is half someone else's. It becomes "one's own" only when the speaker populates it with his own intention, his own accent, when he appropriates the word, adapting it to his own semantic and expressive intention" (Bakhtin 1981, p. 293). Producing utterances inherently entails a process of appropriating the words of others and making them, at least in part, one's own (Wertsch 1998).

A dialogic classroom, as indicated on the left side in Fig. 3.1, is characterized by the inter-animation of student voices (Wertsch 1991). Dialogism generates an internally persuasive discourse that is *open*, allowing students to construct new ways to mean in a spirit consonant with that of performance. When student thinking begins to work in an independent, experimenting, and discriminating way, internally persuasive discourse begins to separate from authoritarian, enforced discourse, the latter being a form of discourse that can only be transmitted, not negotiated, because it imposes fixed meanings. Fostering dialog in the classroom thus creates a more open yet more critical disposition toward discourse and the knowledge construction process. As ideas mix, collide, and are interrogated, students learn that the process of inquiry is a sense making, and hence dialogically constituted, activity. Consistent with Deweyan pragmatism, they learn that socially established "facts" are warranted assertions, hence always tentative in nature, rather than eternally "proven" claims. Dialogism thus sustains inquiry as an open process, and it allows students to participate in the social construction of reality (Berger and Luckmann 1966).

3.3 Learning as Becoming and the Development of Identity

A logical corollary of adopting the theoretical lens of performance on human learning is that the learner's development of self-identity falls naturally within the ambit of such theorization, as depicted in Fig. 3.1. Building upon and extending an idea first mooted by Collen (2003) that inquiry for systemic change must encompass ontology, epistemology, and praxiology, I have articulated a general framework for research on human learning (Chee 2013; Chee et al. 2012) that extends upon this original idea. My theoretical framework focuses on performed identity manifested through *four* mutually constitutive, and hence interdependent, aspects of a *person*: their knowing, doing, being, and valuing (see Fig. 3.2). From this theoretical perspective, the organic unity of the person is held to be of utmost importance. For the purpose of addressing a person's learning, the focus is not on the person's putative "mind" or the person's brain. My proposed approach emphasizes examining the person's behaviors while engaged in situated activity and participating in the discursive practices of his or her social and cultural setting. Consequently, this theorization treats the *person* as a psychosocial entity

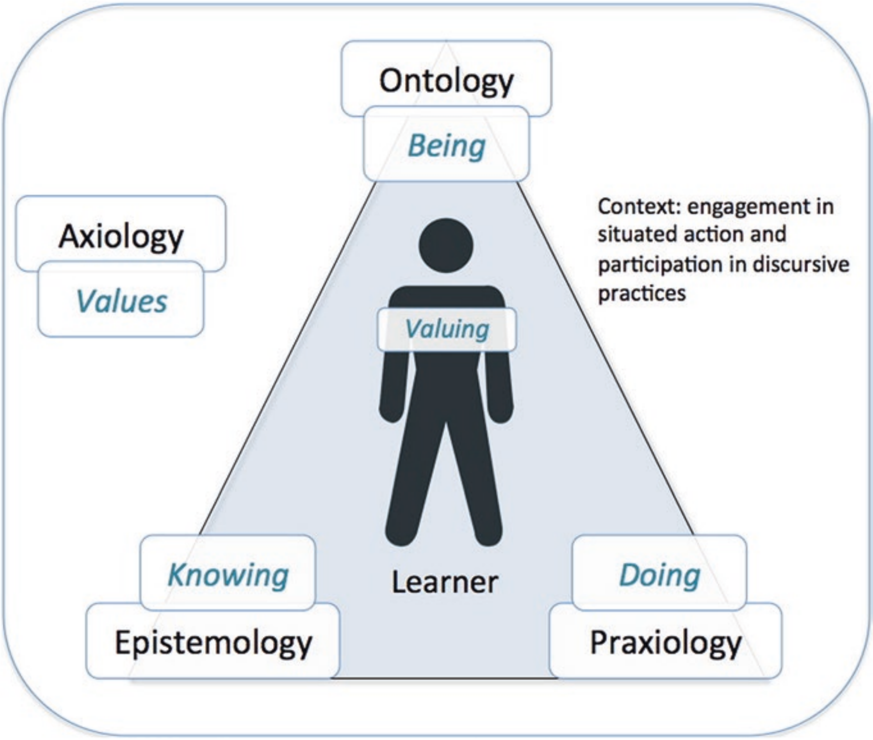

Fig. 3.2 Framework for researching human learning as performed identity

(Brown and Stenner 2009), albeit one that is always in process and in experience (Dewey 1925/1988), rather than a preponderantly cognitive entity.

The theoretical framework for researching human learning as performed identity draws upon four ideas central to Greek thought: *ontos*, *logos*, *praxis*, and *axia*. But, in so doing, it preserves the early process outlook of pre-Socratic philosophers such as Heraclitus (Kirk et al. 1983). *Ontos*, or ontology, refers to the study of human being, human existence, and of what is. *Logos*, referring to epistemology, is the study of human knowing, what can be known, and what constitutes human knowledge. *Praxis*, or praxiology, is the study of action, the practices of human beings, and of what we (as humans) do. *Axia*, or axiology, is the philosophical study of human values. To understand human learning in all its situated complexity, I argue that it is vital for learning to be engaged in and studied *performatively* and, hence, in the context of humans in situated action and participating in discursive practices (Austin 1975; Barad 2003; Clancey 1997). This approach allows us to study them in terms of their becoming. Consequently, a person's *being* during any period of time is simply a snapshot of the person extracted from his or her ongoing trajectory of *becoming*.

Performance constitutes the lived manifestation of personal or self-identity, which, in turn, is constituted by a person's conjoint knowing–doing–being–valuing manifested through engagement in situated action and participation in discursive practices. Knowing–doing–being–valuing should not be construed as independent and separate factors or attributes of a person. Just as *yin–yang* in Chinese philosophy is regarded as inherently coupled and inter-dependent—hence they constitute a duality and not a dualism—knowing–doing–being–valuing, in like manner and by extension, should be regarded as a quadrupality; that is, they are four *aspects* of a *single* entity. Because knowing–doing–being–valuing are process aspects of a person, the terms knowledge, actions, and values are avoided so as not to erroneously connote the idea of independent components of a person. It is helpful to think of knowing–doing–being as a three-colored, tightly interwoven braid wrapped around a central axial cable that represents valuing. The theoretical framing of performed identity asserts the inseparability of knowing, doing, and being because they are coconstitutive. Furthermore, knowing, doing, and being are necessarily embedded within a larger sociocultural context of axiology because they are inherently value-laden activities (Ferré 1996, 1998). Consequently, valuational dispositions ground personal biases, preferences, and choices (Dewey 1938/2008). A performance-centric theorization of human learning thus frames learning as a process of becoming (Semetsky 2006) that progresses from a current state of being. Arising from this process, a person's identity is socially constructed (Wortham 2006). While discourse-based approaches to the study of identity are well established, valid, and much needed (Benwell and Stokoe 2006; de Fina et al. 2006), they yield a partial account of identity and human agency in cultural worlds (Holland et al. 1998) if the praxiological and performative aspects of identity are relegated to the background.

The perspective of human learning as performed identity constitutes the basis upon which the game-based curricula described in Chaps. 4, 5, and 6 have been designed. The three curriculum exemplars relate to the domains of social studies, chemistry, and physics.

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Chapter 4
Statecraft X: Learning Governance by Governing

In this chapter, I describe and explain the Statecraft X game-based learning curriculum for social studies taken by 15-year-old students as part of the formal curriculum in school. Aligned with the performance-theoretic perspective articulated in this book, students learn governance by governing virtual towns in the *Statecraft X* game; they do not merely learn *about* governance. From a pedagogical perspective, students learn by engaging in inquiry, in a manner consistent with the learning tenets set out by Dewey (1909/1991).

4.1 Learning Citizenship and Governance

In the formal education curriculum of independent nation states, it is customary to find a component dedicated to citizenship education. Through this avenue, education administrators seek to educate students to become "good citizens." In Singapore, where I work and conduct my research, the Ministry of Education describes the desired outcomes of education in the following terms: "Education does two things: it develops the individual and educates the citizen" (Ministry of Education 2008b). Education *for* citizenship is thus an explicitly targeted goal of the education system. This goal is addressed by means of social studies in the formal curriculum. The American National Council for Social Studies expresses the purpose of social studies as being "to help young people develop the ability to make informed and reasoned decisions for the public good as citizens of a culturally diverse, democratic society in an interdependent world" (cited in Russell 2011, p. 2). This statement of purpose is equally applicable to Singapore, given its multiracial composition and its standing as an international hub for travel and commerce.

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Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_4

The deeper question that arises from the foregoing, however, is: What is a "good citizen"? Answering this question requires a robust concept or model of citizenship. While viewpoints on citizenship have evolved historically (Alegandro 1993), Dustin (1999) furnishes both a concept and a model of citizenship suited to the concerns of the twenty-first century. He characterizes citizenship in the following terms:

> [C]itizenship is conceived as that secular ethic which defines the membership role in the political community as an inter-related nexus of rights and obligations which provides the cooperative context within which the competition of politics takes place. It is the homeostatic mechanism that maintains the dynamic equilibrium in the tension between the individual and the community. It is also the hermeneutical ethical filter through which the culture we inherit from past is interpreted and re-interpreted into the present on its evolutionary path toward the future. (p. 12)

Thus, there are two distinct dimensions to Dustin's construction of citizenship. The homeostatic dimension represents the tension between the individual and the community. This tension manifests itself through (1) the rights and remedies the individual possesses in relation to the community balanced against the obligations the individual has toward the community and (2) the sanctions that the community may exercise against the individual for failing to meet those said obligations. The hermeneutic dimension is temporal in nature. It provides the wherewithal for the individual to interpret the historical meaning of values such as liberty, equality, and justice as enacted in the past and to construct a worldview of possible human futures through ethical evaluation of the past and present.

As companion to a democratic ideal, citizenship implies a public realm that enables the construction of meaning rather than being a quest for a fixed or predetermined meaning. Consequently, citizens must be engaged in a fourfold dialog: "a dialog with other citizens, a dialog with the past, a dialog with institutions and traditions, and a dialog with himself or herself" (Dustin 1999, p. 17). Therefore, to learn citizenship and to learn governance as a component of citizenship, students must engage in deep yet open dialog. Facilitating a dialogic disposition is imperative in the present climate of sharpening divisions and conflicts that arise from value differences and self-centeredness. As suggested by Santora (2011), "[t]o prepare students as other-centered citizens, educators also need to move dialogue to the center of their instructional practices, creating a third space where students mingle their voices and their emotions with each other's and with the content of social education" (p. 16). Dialog provides a means for "[r]epairing the torn social fabric that increasingly arrays one group against another [and] will require creating an inclusive social dialogue in which individuals can converse from a public space that brings together diverse experiences and points of view" (Darling-Hammond 1997, p. 6). School classrooms need to furnish this public space, albeit a limited one.

Apart from dialog, and consistent with my own emphasis on learner identity, Santora (2011) argues that learners need to learn deeply about themselves and others to develop a profound sense of their multiple, complex, and connected identities. For this to happen, they need to (1) affirm who they are and how they are connected to their social and institutional contexts, (2) understand identity formation as a dynamic, multifaceted process, (3) see their lived experiences as intricately connected to the experiences of others, and (4) realize that others may impose socially constructed identities on them.

The requirements for an effective citizenship curriculum depicted here are a far cry from what takes place in typical classrooms. This divergence is due, in no small measure, to entrenched pedagogical practices that still favor direct instruction due to its relative straightforwardness (under the guise of "knowledge transfer") and resource efficiency, notwithstanding that the approach fails to deliver on outcomes that really matter for long-term social good. However, the seeming ease of "transfer" is attained through reductive over-simplification of complex social and political issues such that the domain of citizenship education morphs into one of authority-approved "facts" and "truths" students must know (about). Consequently, such learning has little, if any, impact on students' understanding and students' lives. Such an outcome is the very antithesis of good teaching, which Eisner (2006) characterized as not being involved with certainty because certainty leads to a dead end.

An alternative to this kind of dead end teaching in social studies is a pedagogy based on inquiry. Turner et al. (2011) characterize this form of pedagogy in the following manner:

> The teacher [is] seen far less as an authority and much more as a guide. Students [are] encouraged to ask questions and seek the answers themselves, questions that [do] not have simple, single, or absolute answers. Students [are] also encouraged to challenge authority, to probe deeply, and to use more scientific approaches and methods. They [are] pushed to probe more deeply, to think at higher levels. (p. 424)

Enacting inquiry pedagogy is typically challenging for teachers because it is a student-centered pedagogy rather than a teacher-centered one. A prerequisite of this approach is that teachers must value the views and voices of students. They must also feel comfortable and be able to facilitate conversations that may touch upon controversial and sensitive topics. Considerable professional and personal maturity are thus needed. For these reasons, the adoption of inquiry pedagogy is not widespread although it is a prime candidate for delivering on the goals of citizenship education.

The curriculum topic that we address through game-based learning is that of governance, which we treat in relation to the broader topic of citizenship given that the two are inherently related. In particular, we want students to be able to adopt multiple perspectives: to see things from the viewpoint of governing (being in the government's shoes) and that of being governed (being in the citizens' shoes). This topic was selected because it was widely perceived by students to be boring, given its customary reduction to teaching *about* the organization and functions of government.

4.1.1 The School Curriculum

The 2008 social studies curriculum set out by the Ministry of Education in Singapore for 15- and 16-year-old students, leading to the General Certificate in Education Ordinary Level examination, describes the aims of the syllabus as enabling students to (a) understand issues that affect the socioeconomic development, the governance, and the future of Singapore; (b) learn from the experiences of other countries to build and sustain a politically viable, socially cohesive, and economically vibrant Singapore; (c) develop thinking and process skills essential for lifelong and independent learning; (d) have a deep sense of shared destiny and national identity; (e) develop into citizens who have empathy toward others and will participate responsibly and sensibly in a multiethnic, multicultural, and multireligious society; and (f) develop into responsible citizens with a global perspective (Ministry of Education 2008a). The statement of aims is laudable. But achieving the stipulated aims is a different matter altogether.

The Ministry's document goes on to state that the specified aims are to be achieved by developing student competence in three areas: (i) knowledge and understanding, (ii) skills and processes, and (iii) values and attitudes. These areas are further decomposed. The detailing of the first two categories is fairly conventional and will not be commented on further. With respect to values and attitudes, the goals are so that students will:

- Appreciate the implications of various decisions, actions, and relationships
- Respect and value diverse perspectives and cultural and historical backgrounds of people and work toward peaceful relationships;
- Appreciate the importance of living in an interdependent community with increasing global connections;
- Recognize the value of participating as ethical, active, and informed citizens in a democratic society within a global community; and
- Experience and appreciate their ability to influence the present and the future.

The document then proceeds to articulate the three objectives, or targets, of assessment for the social studies syllabus. These are as follows: (a) knowledge (related to area knowledge and understanding), (b) constructing explanations (related to skills and processes), and (c) interpreting and evaluating sources and given information (related again to skills and processes). What is striking, by virtue of its omission, is any assessment related to the third area: values and attitudes. It is little surprise, then, to find in practice that teachers conduct their teaching duties to ensure that students are adequately prepared for that which is assessed while neglecting that which is not. The unfortunate outcome is that the values and attitudes portion of the curriculum, the portion that ostensibly is most critical to education *for* being "good citizens," is left to fall by the wayside.

There is also the issue of *how* values and attitudes can be properly assessed. Consider the verbs used in the statement of goals: appreciate, respect, value, recognize, and experience. Would a pencil-and-paper test question of the form "Do you appreciate (such and such): Yes/No" or perhaps using a Likert scale to "measure" how much a student appreciates such-and-such constitute a valid assessment? It is well known that what a respondent says and does, as well as what he or she is actually able to do, may be at wide variance. Saying is neither equivalent to doing, nor does it adequately demonstrate a student's performative capacities. Expressed differently, the specification of the Ministry's aims inherently requires performance-centric forms of evaluation in order to be valid and credible. However, due to the inherent difficulty of performing such evaluations, the simpler step of avoiding evaluation was perhaps taken. A turn to performance places a further discomforting spotlight on the stated objectives: are the selected verbs compelling as indicators of performance capacities? Is *appreciating* what it means to be a good citizen a sufficient or even appropriate indicator of *being* a good citizen? Perhaps the aims require more cogent articulation.

Central to the topic of governance is a set of four principles that students are required to understand. These are as follows:

- Leadership is key.
- Anticipate change and stay relevant.
- Reward for work and work for reward.
- A stake for everyone, opportunities for all.

Within the Singapore context, the first principle emphasizes the importance for the nation to have capable leaders who uphold a high standard of integrity. The second principle foregrounds the need to look ahead, plan ahead, and take needed actions in a timely manner for the nation to remain relevant amidst changing global circumstances. The third principle asserts that benefits must be commensurate with personal effort, and the fourth principle suggests the importance of being nationally rooted amidst opportunities for all stakeholders to advance economically. Students typically memorize these four aphorisms. They are quite happy to do so given that this is not a demanding requirement.

4.1.2 Curriculum Challenges

In practice, there is a widespread perception by both students and teachers that the topic of governance is challenging to address effectively. The topic is often described as being "dry" and "boring" because it is reduced to teaching *about* government instead. Teachers commonly adopt direct instruction to teach this topic. Instruction is accompanied by having students complete worksheets on the topic to hone process skills required by the syllabus. Occasionally, students may also be required to write essays. This approach to teaching governance results in the topic becoming very information centric. It also creates a sense of distance because it is narrated in the language of the third person. It is little surprise, then, that students do not relate well to the topic, perceiving it as distant, remote, and removed from their personal interests and concerns.

Furthermore, as alluded to in the foregoing subsection, the value dimension of the curricular goals is neglected because this aspect of learning appears too difficult to handle from both a teaching as well as assessment perspective.

The foregoing considerations motivated my research team and I to take up the challenge of redesigning the pedagogical treatment of the topic to direct it toward governance rather than learning *about* government. By means of a first-person-oriented performance turn based on the theorization articulated in Chap. 3, we saw the possibility of leveraging on game-based learning to transform a problem situation into an opportunity for pedagogical redesign that would achieve the curricular goals more effectively. Apart from the opportunity to enhance student engagement with the topic, we saw an authentic game as holding out the possibility of developing the valuations and dispositions vital to the becoming of a "good citizen."

4.2 Design for Learning

The overarching theoretical framework that governs the design for learning of the Statecraft X curriculum is the Performance–Play–Dialog (PPD) model depicted in Fig. 4.1.[1] This framework was first explained in Chap. 3. It will be recapitulated briefly here.

The Statecraft X game-based learning curriculum seeks to develop students' deep understanding of governance in terms of the capacity to reflect, think, act, and value in all aspects related to performance of ethical citizenship of the kind described in Sect. 4.1. The curriculum employs a performance-theoretic pedagogy to achieve this aim. This pedagogy is directed toward development of the citizen-as-*person* (as opposed to, say, the citizen's "mind" or the citizen's emotions). This orientation spans the person in his or her entirety, encompassing the person's unified knowing–doing–being–valuing, as explained in Sect. 3.3. A student's learning in this curriculum is constituted by his or her enacted performance (in the theoretical sense of the term) of the curriculum. *Performance* is instantiated by means of coupling the activity of playing the *Statecraft X* mobile game—marking the element of *Play*—with teacher-facilitated classroom dialog among peers—marking the element of *Dialog*—to foster an expansive, multifaceted, and nuanced grasp of the complex and intertwined issues entailed in the process of learning to govern by governing. The activity of dialog draws upon students' game play experience to make sense of and construct meanings related to the role and responsibility of governing. Leveraging upon dialog, students' voices and individual perspectives are elicited to cultivate an understanding that possesses a high degree of "truthfulness"—the criterion of pragmatic inquiry—rather than transmitting a singular monolithic Truth imposed as a "right answer" to the challenge of governance.

[1]This figure is identical to Fig. 3.1. It is replicated here for ease of reference as well as for readers who may not have access to Chap. 3.

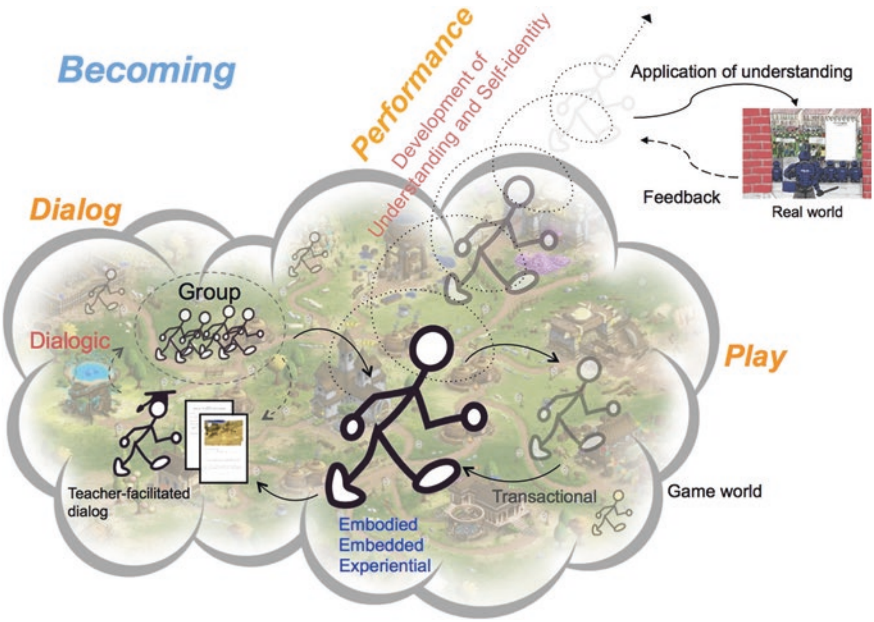

Fig. 4.1 *Statecraft X* Performance–Play–Dialog game-based learning model

As indicated on the right side of Fig. 4.1, students are "inserted" into the persistent game world when the curriculum commences. As the game unfolds, they must make decisions, grapple with in-game events, and deal with challenges related to governing virtual towns in the game space. In this manner, the game carries the curriculum forward, and, in this sense, the curriculum is literally game-*based*. The left side of the figure depicts students' periodic engagement in classroom dialog. During these sessions, they strive to make sense of, and find a personal position on, the issues related to governance that engagement in play throws up, for example, providing for housing, health care, defense, and happiness of the towns' citizens, and managing the trade and immigration flows in and out of towns. Students' participation in the coupled activity of play–dialog constitutes a performance of who they are as constitutive of their identity-in-the-making. Put differently, their *being* in play–dialog at any moment in time is but a snapshot of their *becoming*, along a temporal trajectory of development, in relation to governance and citizenship. By engaging in the process of performance, students construct an understanding of governance in relation to their continually evolving self-identity.

Moving to a lower level of abstraction, the Statecraft X curriculum constitutes an inquiry curriculum because the *Statecraft X* game instantiates a first person, lived space of inquiry.[2] As Gee (2012) argues, good games-for-learning is a model of twenty-first-century learning because they entail doing, making decisions, solving problems, and player-to-player interaction and communication, rather than being about the presentation of content. Thus, students are never presented with subject content while playing the *Statecraft X* game, and the four canonical principles of governance given in the textbook and expressed in Sect. 4.1.1 are never encountered as language-based descriptions. Rather, by design, the principles are allowed to play out via the activity of game play.

At the level of implementation, the Statecraft X curriculum extends over a period of three weeks. It offers teachers a different pedagogical approach for teaching the topic of governance in social studies, a compulsory subject for 15-year-old students in Singapore schools. Students typically have two social studies lessons each week, with each lesson lasting between 45 and 60 min, depending on the particular school. Consequently, the implementation of the curriculum spans six lessons. In a typical scenario, students play *Statecraft X* for about two weeks: from the conclusion of lesson 1 to shortly prior to lesson 6. Lesson 1 entails outlining the curriculum and its goals to the students, followed by an overview of the game's user interface. Students are then loaned an Apple™ iPhone® and set off on playing the game. Lessons 2–5 are dialogic classroom sessions that take place during social studies curriculum time. As mentioned, teachers probe students on their experience of game play to date, what challenges they faced, what decisions they made, and what actions they took in the game. They use these student inputs as resources to interrogate issues related to the challenges of governance, relating these challenges directly to what students did in the game and what they say in class: that is, students' *own* performance. In this manner, teachers also foster student reflexivity as they encourage students to reflect on their own value positions taken in the course of playing the game and in justifying their actions through the process of dialogic conversation. Consequently, students develop a sense of personhood and self-identity: who they are, what they stand for, and why. To build relations between events that take place in the game world and pertinent events that take place, or have recently taken place, in Singapore and the world at large, teachers adopt the strategy of "playing between worlds" (Taylor 2006) in order to help students see the connections and parallels between experiences in the game world and experiences in the real world. In this manner, the relevance of social studies to students' lives is deepened.

Lesson 6 is a wrap-up lesson. During this lesson, students adopt their in-game persona, as lords and ladies who have governed towns in the game world of Velar, a medieval fantasy kingdom. They make a public speech to fellow governors arguing why they should be elected to the interim governing council of the kingdom

[2]This space may also be viewed as a virtual space by virtue of it being an immersive digital world, but being virtual in this sense does not in any way detract from the realism of the I-ness of engaging in game play or the first-person outcomes of learning that ensue through participation in the curriculum.

that will rule Velar until the young prince Junio comes of age to ascend the throne following the death of his father, King Topez. In this speech, students are required to identify the problems and challenges being faced by Velar and to suggest solutions and remedies, supported by good reasons and argumentation, for dealing with these challenges. Based on these speeches, a small number of students are duly "elected" to the governing council. Thus, by design, the activities in the game world find closure in the real world of the classroom, reinforcing the seamless bridging between worlds articulated by Taylor (2006). During the final lesson, the teacher also conducts a wrap-up of the curriculum topic, drawing upon students' learning experiences over the course of enacting the curriculum. Finally, the iPhones are collected from the students. Subsequent to the conclusion of the three-week curriculum period, students are required to write a personal essay, aligned to the speech they delivered, but redirected to Singapore's problems and challenges related to governance. This activity serves the requirement of assessment in the school context. It also provides a summative learning artifact that we use to evaluate the quality of student learning from a research perspective.

The typical classroom size for 15-year-olds in Singapore schools is 40 students. As the *Statecraft X* multiplayer game supports 20 students, we divide the class into two groups and run two independent game sessions concurrently for the duration of the curriculum.

4.3 The *Statecraft X* Game and Game Play

Technically, the *Statecraft X* game is a client–server system. It was designed to support mobile game play on Apple iPhones and iPads using wireless connectivity. However, in situations where such devices are unavailable, the game can also be played on desktop and laptop computers equipped with a standard Web browser with Internet connection. Figure 4.2 shows the game's opening splash screen when played on an iPhone 3G, the model that was current when the game was released.

Statecraft X is a multiplayer, simulation-based strategy game. Each game session of 20 students is divided into four factions of five students each. A faction is a group of like-minded citizens who share a broadly common ideological position with respect to governance. A faction in the game world is the analog of a political party in the real world. Every student, positioned as a governor of an assigned town in the kingdom of Velar at the commencement of the game, is also a citizen of Velar. All citizens belong to one of four races as depicted in Fig. 4.3: humans (left), dwarves (front), trolls (right), and elves (back). Consequently, each student, as governor, has a race and belongs to a faction.

When the game is run the first time, the backstory plays on the game device as a movie clip. The clip narrates how the inhabitants of Velar were once part of the neighboring kingdom, Salfreda, whose king exacted their crops, leading to their living a life of poverty (see Fig. 4.4). This oppression triggered a rebellion led by Topez, a young farmer. After three years of fighting, the king of Salfreda acceded

Fig. 4.2 Opening splash screen of the *Statecraft X* game

Fig. 4.3 The four races in *Statecraft X*: humans, dwarves, trolls, and elves

to secession by the rebels, and the kingdom of Velar was born. Sixty-seven years later, Topez, who had been crowned the first king of Velar, has died, leaving behind no heir old enough to ascend the throne (see Fig. 4.5). Consequently, four political factions compete to exercise influence over the kingdom. In time, an interim council of governors, drawn from these factions, will be elected to oversee the affairs of the kingdom until the young prince Junio, son of Topez, comes of age to ascend the throne. With this background context, students embark on their experience of game play.

Fig. 4.4 Enforced poverty due to oppression by the king of Salfreda

Fig. 4.5 The passing away of King Topez, king of Velar

When students first log into the game, they are asked to choose their in-game gender and race (see Fig. 4.6). As they improve their level of well-being in the game, their appearance improves as well.

A student begins game play as the assigned governor of a town in Velar. Figure 4.7 shows the town map of a typical town.

The town is enclosed within a fortified wall, which has a gate for Velar's citizens to enter and leave the town as they choose. Within the town, there is a water

Fig. 4.6 Selecting the player's in-game gender and race

Fig. 4.7 Screenshot of a town in Velar

tower. Citizens in the town are found living in slums because no houses have yet been built. The town also has a town hall, a farm, and a trading post. The game allows players to build a healing center (the medieval equivalent of a hospital), defense barracks for soldiers, a wood mill for the production of wood, and a factory for the production of iron from ore. The top pane of the game's town interface indicates the town's population and resources, shown in the following order: town population, gold (the currency of the kingdom), water, food, wood, ore, and crystal (a luxury good used to create adornments that indicate the social status of citizens). The four icons on the right side provide players with the functionality of building, modifying, and removing housing, production facilities (mill and factory), the healing center, and the defense barracks.

Fig. 4.8 Water tower, with action icons, indicating zero water output

Statecraft X adheres to a turn-based model of game execution; that is, actions taken by players are accumulated and executed at the end of every game turn, which is typically after one hour. Students are assigned a number of action points, shown on the top left under the resource bar, that can be used during each turn of the game. No further game play actions can be taken during a turn when the action points have been fully utilized. These points are replenished at commencement of the next turn. The indicator in the middle, under the resource pane, is the countdown timer showing the time remaining till the end of the current turn. The icons on the left side of the game interface, from top to bottom, activate the game's (1) world map where battles between competing factions as well as against the soldier's of Salfreda play out, (2) wizard, an in-game help system, and (3) multiuser real-time chat system that allows communication between individual players as well as between the player and various pertinent groups such as factions. The icon on the bottom right activates the game statistics. It allows the player to query macro-level information at the town level (for example, the number of towns and citizens the player has oversight of, the average health and happiness levels of those citizens, the average trust levels between the different races in these towns, and the income and expenditure of the towns). It also provides access to a historical log of significant events that have taken place recently in the game, for example, a bandit attack.

Game play in Statecraft X takes place in four distinct phases, with the level of complexity of game play rising in each successive phase of the game. The first phase focuses on meeting the basic needs of town citizens while ensuring the overall economic viability of the town. These needs include those of food, water, housing, health care, and security. We shall consider the provision of water as an example. While the town is equipped with a water tower (see Fig. 4.8), it produces no water until citizens are employed and put to work there (see Fig. 4.9). Thus, players must recruit workers from the pool of unemployed citizens, decide how

Fig. 4.9 Managing workers at the water tower

much to pay them, and decide how much the water will be sold for. These actions have direct implications for the ongoing viability of water production as an economic activity within the town. Students quickly learn that time is a critical factor in governance because actions taken do not bear fruit immediately. Thus, the water tower workers need to be trained before they become productive. Similarly, establishing a farm does not yield crops, and hence food for citizens, immediately. The crops need time to grow before they can be harvested, and this requirement for the passage of time is implemented through the number of game turns needed before harvesting becomes possible.

As students play the game, events such as epidemics, bandit attacks, and the influx of refugees occur. The game administrator sets up the timings of these events before game play commences. If a student has not had the foresight to embark on building a healing center in good time, the onset of the epidemic takes a heavy toll on the lives of citizens, and many of them die. Likewise, if no provision has been made for the town's defense, bandits pillage the town and food resources "disappear." In this manner, by design, the game instantiates the fundamental principle of game play; namely, that actions of both commission as well as omission have important consequences. Students, as players, fare better or worse in the game depending on the extent to which they have acted in a manner consistent with the targeted principle of governance: "Anticipate change and stay relevant."

The second phase of the game kicks in about one-quarter into the game. During this phase, players must commence advanced development of their towns, providing for the education of its citizens, the development of industry and trade, and the pursuit of cultural activities that enhance the happiness of citizens. However, there are complications. Both wood and ore are needed for the mill and factory in the town to operate. But, by design, each town is endowed with wood or ore, and not both.

Fig. 4.10 Checking the town citizens' happiness, health, and earnings

Construction of the mill and factory, however, requires *both* wood and ore, presenting players with a challenge. To overcome this challenge, they must engage in trade with *other* towns via the trading post where they negotiate the terms of trade exchanges. This design establishes the need for *cooperation* with governors of other towns to achieve a win-win outcome.

A critical indicator of how well students are playing the game is that of citizen happiness. Players find themselves having to address this issue in various guises. There may be occasional encounters with (virtual) citizens who pop up (through an in-game notification) and "grumble" about various issues, for example, being out of work. Alternatively, citizens may be unhappy due to being overtaxed by the governor (players can set different tax scales and apply different scales to different races) or being overworked because economic success is being relentlessly pursued at the expense of work–life balance. Or, worker productivity takes a hit because of low levels of trust between the different citizen races. By going to the town hall, players can interrogate the happiness (and health) level of a town's citizens taken together (see Fig. 4.10) or by individual citizen. They can also determine the trust level between races. In this manner, students are sensitized to the need to maintain multiracial harmony among their town's citizens. This challenge is especially severe given the tortured history of race relations that plague the four races of Velar. The dwarves hail from the northern Kingdom of Nibelung, a cold and mountainous region. They are technologically advanced, having invented tools and weapons from the ore and metal found in the mountains. They have a strained relationship with the trolls. The trolls, a nomadic tribe of sheepherders, come from the hilly western Kingdom of Alphege. They are supernatural beings who are friendly with elves. Humans emigrated north from the swampland in the southern Kingdom of Auki. They were traditionally seafarers who relied on fishing as a livelihood. As immigrants, they tend to be seen as outsiders by the other races.

Elves hail from the Kingdom of Salfreda, their ancestral home in the east. They live in and around forests, from which they gain magical power. The elves have a good relationship with the trolls. Given that Velar seceded from Salfreda, elves are often treated with suspicion.

The third phase of the game commences around midway into the game.[3] Just as political parties seek to extend their influence in a country, students, as governors with a factional affiliation, now also attempt to extend their governorship over neighboring "neutral" towns while still attending to their existing citizens' basic needs and higher-order needs that were the focus of the first two phases. Doing so improves the standing of a player, as well as the faction to which he or she belongs, because town ownership directly entails ownership of the town's resources as well. For this reason, players are apt to engage in extending their governorship of towns as a faction-level cooperative activity. To further strengthen cooperation between players of a faction, gold, the nation's currency, is treated as a faction resource rather than an individual governor's resource in the game. In this manner, all contributions to the faction pool of gold are welcome, but reckless or extravagant expenditures invite questioning and criticism from other faction members. This design helps to foster player communication as well as personal reflection.

Neutral towns have no active governor at the commencement of the game, and they are initially managed by artificial intelligence. Students may attempt to expand their sphere of influence by one of three means: (1) seeking to establish friendly ties with inhabitants of that town, (2) organizing a rally in that town to develop support among the citizens there to enlist the player as their governor, or (3) attempt to win over the town by forceful means, using the soldiers at the player's disposal, assuming the player has adequately built up his or her defense forces in the first place (see Fig. 4.11).

Here, we see the seeds of potential *conflict* between players being sown as part of the challenge of governance. Attempting to take over towns forcefully might be the most expeditious means of expanding one's control and influence, especially when the power of a player's armed forces greatly exceeds that of the target town, which after the initial stages of the game are likely to be governed by a human player rather than by artificial intelligence. As students decide how to proceed, they manifest, by their action, their disposition and sense of valuation between alternative paths of action. Establishing friendly ties represents a "soft power" approach to expanding influence, while taking over by means of overwhelming force represents a "hard power" approach. Choice of a suitable approach is, to a significant measure, a function of the racial composition of the town's citizens, the race of the player-as-governor, and the degree of trust between races

[3]Note that this description of game phases indicates the broad flow of how game play typically emerges. It does not signify a rigid compartmentalization of distinct segments of game play. Thus, it is entirely possible for players to begin extending their influence over other towns in phase two of game play.

Fig. 4.11 Expanding a player's influence to a neighboring town

when the decision is exercised. The racial factor is further complicated by the fact that the racial composition of a town may change, sometimes quite dramatically, over time. Thus, if a player-as-governor performs his role poorly, the citizens of his town may leave for another town whose governor is serving her citizens well. Constant armed conflict between towns aligned to different factional coalitions may also prompt an influx of refugees into a nearby town. Toward the end of this third phase of the game, players hear "rumors" of Salfredan troops massing on the eastern border. How should they respond to this global threat to Velar? Will they still continue with their factional politics and confrontations, or might they realize the importance of their common destiny and cooperate to confront a threat to their national existence?

The fourth phase of the game, approximately three quarters into the game, is marked by an invasion by the Kingdom of Salfreda. Governors of towns located near the eastern border bear the brunt of battle given their geographical proximity to Salfreda. The game provides players with access to a scrollable map of the entire terrain of Velar. This map includes the location of towns, allowing them to develop a spatial sense of the towns they govern in relation to other towns (see Fig. 4.12). (This map is helpful not only in times of battle but also for determining nearby towns with which to trade.) Just as epidemics swept through the land in multiple waves in the earlier part of the game, with each wave being more severe than the previous one, so too the invasion takes place in waves of increasing severity. How do governors of towns located away from the area of battle respond to the onset of the invasion? Do they send their own soldiers to participate in the broader war or ride on this development to further advance their personal well-being and prestige, while their fellow governors are distracted?

The inter-faction battles and the warfare with Salfreda take place on the *Statecraft X* world map (see Fig. 4.13). This map allows players to move their

Fig. 4.12 Scrollable map of towns in the Kingdom of Velar

Fig. 4.13 World map showing battle being fought by factional forces

defense forces—comprising archers, swordsmen, gunners, and cavalry—across the terrain of Velar. As with the town map, each player is allotted a number of points, called combat points in the context of the world map, with which to engage in battle during each game turn. These points are shown in the top-left corner of the game interface. Each fighting unit has associated with it a skill level, signifying how well trained the unit is, and a health level, signifying the life strength of the unit.

The *Statecraft X* game ends when the time available for game play, as set out by the curriculum schedule, runs out. In this sense, the termination of game play is temporally determined rather than achievement determined. Notwithstanding, the end of the game is always associated with an outcome state related to how well students as a whole have enacted the challenge of governing Velar. If the Salfredan army overruns the players' towns, they *collectively* lose the game: the worst possible outcome. If the players successfully repel the invasion, they remain in the game: a successful outcome. The larger objective, however, is to have repelled the invasion and created a stable, prosperous, and peaceful nation where Velar's multiracial, multifaction citizens live happily and in mutual harmony. By positioning the outcome of play as a collective outcome, it is hoped that the dictum of "swimming or sinking together" as a nation is reinforced.

A key learning point of the Statecraft X curriculum is to help students deeply understand that governance is a complex challenge that affords no simple "right answers." Rather, effective governance depends on choices that entail trade-offs based on values associated with viable alternative courses of action. By design, the game plays on the trade-off between economic wealth and citizen happiness. These factors have a strong tendency, in actual game play, to move in opposite directions (due to the manner in which the game simulation was intentionally programmed). Consequently, from the perspective of curriculum implementation, the student faction that has the (equally weighted) maximum economic resources and highest level of citizen happiness is regarded as the winning team, regardless of the specific game outcome. In practice, we often find that, at the end of the curriculum period, students are still battling against the Salfredan forces. An ongoing war of attrition is a frequent outcome. We regard this outcome as a poor outcome because the territorial integrity of Velar has been compromised. However, this outcome is better than the worst possible outcome: that of being entirely overrun by Salfreda.

It is hoped that the foregoing description adequately furnishes readers with a concrete and elaborate sense of what it is like to play *Statecraft X*. It should be reiterated that the game's design intentionally supports an inquiry-oriented curriculum. Thus, the game engenders first-person challenges and dilemmas that students must wrestle with and work through in the spirit of problem-solving, open-minded experimentation, and considerable peer-to-peer negotiation so as to achieve the best possible outcome, where the meaning of "best" must itself be coconstructed among the students. Game play instantiates a learning environment and a context for deep interrogation of social issues, personal choices, and political implications, through communicative dialog. It is emphasized that there is no "right" way to play the game. Any desire expressed by students to find a "right" way to play is discouraged because students learn most effectively through expectation failure (Schank 2002). When their actions fail to yield the positive outcomes they seek, they realize there must a problem with their understanding of the situation. Hence, a re-examination of that understanding is required, as part of the natural process of inquiry, and triggers reflection on the student's part.

Aligned with the spirit of there being no "right way" to play *Statecraft X*, we adopt a very accommodating attitude toward students who engage in transgressive game play. Students who wish to experiment with alternative models of

Fig. 4.14 The *Statecraft X* administrator Web page

governance, such as that of a tyrannical dictatorship or a welfare state, are free to do so. The former model will lead to great citizen unhappiness and citizen revolts against town governors, while the latter model will lead to faction bankruptcy. As governors, students can also practice racial discrimination if they so choose. Because the game allows them to set different tax scales for the different races, they can, for instance, oppress the elves who are the dominant race in Salfreda and see what happens. In this manner, the game as an experimental space of action-coupled-to-consequence supports not only (game) play but also the creative play of imagination (Thomas and Brown 2007).

A Web-based teacher tool, referred to as the "*Statecraft X* Administrator Page," is provided to assist teachers in their role of game-based dialog facilitators (see Fig. 4.14). The Statecraft X game simulation produces a very large amount of game play data and simulation variable values that change continually over time. It would be inappropriate to burden teachers with this mass of over-detailed information. Consequently, information presented in the teacher tool is shown at a higher level of abstraction to better meet the needs of teachers who only require a general sense of the movement and direction of game play. The top half of the information panel shows all the towns in Velar and, by means of color-coding, indicates which faction controls which town. The lower half of the panel shows information

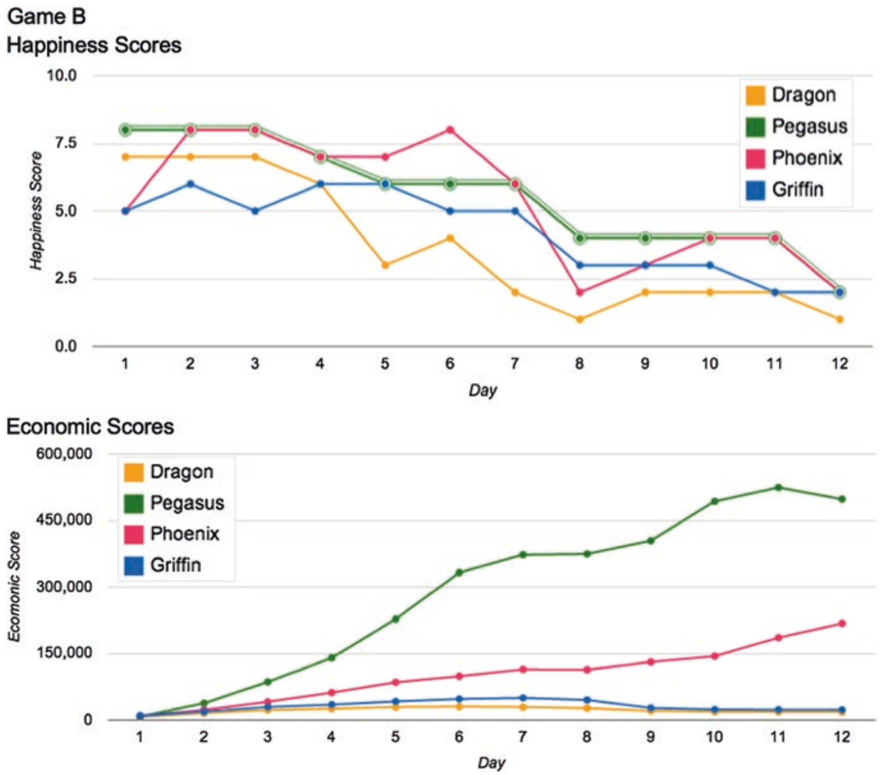

Fig. 4.15 Comparative happiness and economic scores shown over time

related to each faction, including the number of towns and citizens governed by the faction, the average health and happiness of citizens in those towns, average trust metrics of citizens in the faction as well as average trust levels of the individual races, and information related to inflows and outflows of gold. A slider bar at the bottom of the panel allows teachers to interrogate the data over time to obtain some feel for how the fortunes of each faction have shifted. In addition, the teacher tool provides the functionality for teachers to display and print the comparative indicators of economic wealth and citizen happiness over time. Figure 4.15 is an illustration from classroom research. The color-coded graph shows how students had a difficult time striking a good balance between the two variables. The longitudinal trajectory is clear: As economic prosperity improved, especially for the Pegasus faction, citizen happiness plummeted.

Last, but not least, Figs. 4.16 and 4.17 illustrate the *Statecraft X* game on an Apple iPad. The interface design leverages the larger amount of screen estate available on this device. However, the game functionality is the same between the iPhone and iPad versions of *Statecraft X*.

Fig. 4.16 *Statecraft X* town map on an Apple iPad

Fig. 4.17 *Statecraft X* world map on an Apple iPad

4.4 Student Learning Outcomes

The Statecraft X game-based learning work described in this chapter has been the subject of two rounds of research funding. For this reason, we have carried out more than 10 classroom research interventions. The research in the first project was formative in orientation, because it was coupled with the game design, development, and testing effort. Research in the second project focused primarily on teacher professional development. Its primary goal was to foster teachers' capacity to enact the pedagogy of the game-based learning curriculum.

Published empirical research outcomes related to student learning can be found in Chee et al. (2009, 2013). Here, I share a set of research findings that have not been published previously. The research study in question took place in February 2012 in a government secondary school. Forty-one students from a mixed ability class of 15-year-old boys and girls participated in the Statecraft X curriculum in the manner described in Sect. 4.2. As a summative assessment, the students were required to write an essay, under test conditions, based on the following question, which aligned to the writing assessment required in the social studies curriculum:

> Singapore has a number of well-known political blog sites such as *mrbrown*, *Temasek Review*, and *The Online Citizen*.
>
> You are a concerned, responsible, and active Singapore citizen. You wish to set up your own blog site to address issues of deep personal concern. These issues may relate to sustaining economic prosperity, maintaining racial harmony, managing immigration, encouraging international trade, establishing strong national defense, handling diplomatic relations, and developing a global citizenry that remains rooted locally.
>
> You are preparing the very first entry on your blog site. In preparation for this entry, write an essay of about 300 words to identify 3 or 4 issues that you are most concerned about, to express your views concerning these issues, and to suggest how the Singapore government should deal with the issues that you identify. To create a positive impact, make your statement as balanced, persuasive, and well supported by evidence as possible.

Students' essays were coded and graded on the basis of a four-level rubric included in Chee et al. (2013). The rubric assesses students' essays on four qualitative criteria: (1) multiple viewpoints with balanced, coherent perspective, (2) proposed solutions supported by strong evidence and argumentation, (3) disposition of active citizen, and (4) persuasiveness. Students belonging to the control group, comprising pupils of similar ability, also took the summative assessment under test conditions in school. A research fellow graded essays of both groups of students. A separate researcher independently graded approximately 25 % of the essays to test for, and confirm, grading reliability. It should be noted that, given the school context, the vehicle of the essay was the most suitable means of assessing student learning outcomes arising from the game-based learning curriculum. While criteria (1) and (2) reflect assessments usually related to independent and critical thinking in schools, criteria (3) and (4) orient toward performance and delve into student voice and the degree of commitment to ideas that are voiced through essay writing.

Table 4.1 Significance test of difference between intervention and control classes

Criterion	Group	*N*	Mean	*SD*	*t*	*df*	*p*
Multiple viewpoints	Intervention	41	2.15	0.760	4.33	76	<0.001
	Control	37	1.49	0.559			
Proposed solutions	Intervention	41	2.00	0.671	5.13	76	<0.001
	Control	37	1.30	0.520			
Disposition of active citizen	Intervention	41	2.10	0.800	7.34	76	<0.001
	Control	37	1.08	0.277			
Persuasiveness	Intervention	41	2.07	0.755	5.87	76	<0.001
	Control	37	1.24	0.435			

Table 4.1 shows the summary table of results from grading the students' essays. The table shows that, for all criteria, students from the intervention class outperformed those in the control class, based on criterion means coded from 1 (lowest) to 4 (highest). The difference between classes is statistically significant for each criterion, based on independent *t*-tests of group difference.

It would be inappropriate to take clear and positive research outcomes, such as the one above, for granted. As pointed out in Chee (2013), it is never the game (as such) that works; rather, it is teachers and students who collectively work to make the game-based curriculum "work." Consequently, teacher preparation and student willingness to invest in both game play and engagement in classroom dialog are vital to enacting the curriculum successfully.

Students who are willing to make the required investment of effort in learning find the curriculum a satisfying way to learn. Here, I share two samples of feedback from students who responded to the curriculum in an emotionally positive way:

> The game has been an ingenious way in allowing the students to have a hands-on experience in governing a town, instead of the classroom lessons we usually have. Statecraft has been a real eye-opener as I was able to relate to the issues and challenges the government face in the midst of running a country. It has shown that a lot of careful thinking is needed to run a country well. This experience should be incorporated into the social studies lesson, as it is more engaging and interesting. Certainly, it has been a privilege to be able to play Statecraft. [Student 1]

> Statecraft X not only puts us in the shoes of the governors, but also introduces to us about the different problems a town or country can have. It also enables us to learn that every action a governor takes, there would be an after effect, be it positive or negative effect. It is also a more interesting and interactive way to study Social Studies as, I feel that using hands-on study methods like being a governor of a virtual town, can help one to understand and learn better, rather than reading from the text book which most of the time is just memorising and not understanding the logic behind it. Thus, I feel that Statecraft X is able to help us understand better what governors face rather than from the textbook which can be quite shallow. [Student 2]

Thus, it is critical for teachers to explain the rationale of the Statecraft X game-based learning curriculum prior to commencement of the lessons and to persuade students of the worthwhileness, to themselves, of the curriculum and to invest in it. Ordinarily, students, at least in Singapore schools, do not use authentic digital games in formal curriculum, and neither are they engaged in a dialogic curriculum that requires and values their voice on issues related to public governance. Consequently, this step of obtaining students' "buy-in" to the curriculum is a pivotal factor that impacts learning outcomes.

4.5 Facilitating Take-up of the *Statecraft X* Curriculum in Schools

In this closing section of the chapter, I take the opportunity to comment on several macro-level and contextual issues that surround the enterprise of bringing authentic game-based learning, predicated on the paradigm of games-to-learn, into formal curriculum. First, I reiterate that the value of digital games for education lies in harnessing it as a tool for learning rather than for instructing students *about* subject content. Twenty-first-century education demands this shift of focus away from emphasizing content and the learning of simplistic piecemeal skills—reflected in the conventional discourse of schooling for "knowledge and skills"—to a focus on developing students' abilities in order to make a meaningful impact on their lives, including their capacities for performance in the domain of learning and their identity with respect to that domain. The design of the Statecraft X curriculum necessarily embeds a tradeoff between content mastery and performance mastery given the constraint of a finite and non-negotiable amount of curriculum time that teachers faced in practice. Given the learning objectives set out, the trade-off favors performance goals.

Second, schools commonly follow, and by implication value, outcomes related to conventional schooling discussed in Chap. 2. However, innovation inherently requires change, and as Biesta (2010) points out, consistent with the spirit of pragmatism, open-mindedness associated with change requires a willingness to reconsider not only means employed but also ends, or goals, targeted. While there has been much rhetoric associated with twenty-first-century learning since the turn of the century, the practice of schooling has, in general, been little impacted. For substantive change to occur, teacher professional development and teacher preparation programs need to be re-evaluated and reconstructed. My own efforts directed toward teacher professional development in relation to the Statecraft X curriculum are documented in Chee et al. (in press-a), Chee et al. (2014), and Mehrotra et al. (2014).

Third, the educational technology community is much concerned with the challenge of scaling technological innovation in formal learning because such innovations have commonly had little real impact on teaching practice in schools (Coburn 2003; Dede et al. 2005; McDonald et al. 2006). Our research on teacher professional development for game-based learning suggests that a constant weakness of the existing literature is a failure to consider the human side of school change (Evans 2001). In Chee et al. (in press-b), we suggest that it is critical to pay attention to teacher identity in efforts to help teachers "shift" their teaching practice as part of a broader movement toward educational reform and the reconstruction of practice. This topic is taken up further in Chap. 7.

In the next chapter, I turn my attention to the chemistry curriculum based on the educational game *Legends of Alkhimia*.

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Chapter 5
Legends of Alkhimia: Engaging in Scientific Inquiry by Being a Chemist

In this chapter, I turn my attention to 13- and 14-year-olds learning chemistry as part of their general science education in formal curriculum. The study of chemistry is necessarily located within the broader context of science education carried out in schools. As indicated in Sect. 2.1, available educational games for chemistry tend to be designed as games-to-teach students about chemistry content rather than games-to-learn chemistry. Consequently, they are mostly used as educational resources to complement direct instruction, to support content revision, or for the purpose of assessing "facts" related to chemistry. The Legends of Alkhimia curriculum, in contrast, offers a game-based curriculum that enables students to learn chemistry through inquiry, with the process being facilitated by teachers. This curriculum exemplifies the paradigm of games-to-learn rather than that of games-to-teach.

5.1 Culture of Learning Chemistry in Schools and the Need for Scientific Inquiry

Typical chemistry textbooks present the field as a *fait accompli* represented by a body of stable, "proven" facts. For example, a textbook by Heyworth (2002) used by 14-year-olds in Singapore schools makes the following claims:

- Atoms are so small that nobody has ever seen a single atom. But scientists are *certain* they exist. (p. 26, italics added)
- Scientists have *discovered* that atoms are made up of three smaller kinds of particles—protons, neutrons and electrons. (p. 32, italics added)
- It's a *Fact*!
  In 1915, Ernest Rutherford fired particles containing protons at some nitrogen gas (atoms of proton number 7). Protons entered the nuclei of the nitrogen atoms and changed them into oxygen atoms (of proton number 8). (p. 35, sidebar entry, italics added)

Y.S. Chee, *Games-To-Teach or Games-To-Learn*,
Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_5

The authoritative textbook discourse of chemistry as a body of knowledge consisting of *facts* that have been *discovered* and are *certain* is indeed striking. Leaning on authorial privilege, the writer misrepresents chemistry as a ready-made science-for-the-taking, through the act of discovery, in a preconfigured and prelabeled world. All notions of science making, individual sense making, and social knowledge construction are jettisoned for the apparent convenience of a reduced and simplified account of "reality" that teenagers can understand. While such a device may be appealing to textbook authors, such writing is rooted in a false objectivist ontology while being encased within a vacuous rhetoric of experimentation, observation, and verification, which suggests a constructivist epistemology. However, any concurrent claim to an objectivist ontology and a constructivist epistemology constitutes a logical contradiction, given the interdependence between ontology and epistemology (Barad 2007; Dewey and Bentley 1949/1991).

The excerpts from Heyworth (2002) beg several questions. First, if atoms are so small that they have never been seen, how can scientists be certain of their existence? A student able to think critically and independently would find such a claim un-trustworthy. Second, the author's claim that the composition of atoms—in terms of protons, neutrons, and electrons—was simply "discovered," suggests that atom composition is constitutive of a preconfigured (chemical) world and that the act of discovery was a fortuitous happenstance rather than a directed effort on the part of Rutherford (and others too) to make sense of the composition of matter. This claim also negates the role of language in science making by conveying the notion of a prelabeled world (Gregory 1988). Third, asserting Rutherford's experimental actions that transformed nitrogen atoms into oxygen atoms as a fact preempts any question of how or why this occurred. The tenor of the text is that of the authoritative monolog. No student questioning is invited or entertained. It is little surprise, then, that the effect of schooling, predicated on textbooks of this kind, has been to imbibe a classroom culture of science learning based on memorization and the reproduction of "facts" understood as immutable truth. Students' understanding of the chemical world is reduced to black and white, to right or wrong, with no grays in between. To the extent that learning of chemistry takes place in the school laboratory, students are required to follow prespecified procedures strictly, with no deviation permitted for the sake of safety. Thus, the core activity of experimentation is once again negated in the procedures of what is now an experiment in name only. Consequently, students feel a genuine loss of agency with respect to their learning because the overriding sense is one of the enforced compliances rather than experimental investigation and sense making.

Classroom learning of chemistry is not aided by widespread use of the metaphor of *discovery* in science (Langley et al. 1987; Popper 2002) because the term suggests an uncovering of something previously hidden rather than the construction of a best possible explanation at a certain point in time. In addition, little is conveyed of Popper's notion that scientific theories are subject only to falsification and can never be proven. Despite these limitations, it is common to hear students speak of theories as having been "proven." In all likelihood, the notion of proof that students adopt in science represents an over-generalization of this concept that is carried over from their study of mathematics. However, mathematics deals with closed systems of formal reasoning, while science addresses the open systems of nature, rendering the (over) generalization invalid. Students thus often fail to disambiguate between the knowledge building enterprise of science and that of mathematics, believing that science makes certain and enduring claims. They also seem unaware of the need for speculation and systematic observation in scientific work, and they fail to distinguish between correlational and exact procedures in the construction of science (Robinson 1998b). It is little surprise, then, that students typically leave school with a seriously mistaken understanding of the nature of science (McComas et al. 1998). Science educators acknowledge the importance of helping students understand the nature of science. McComas et al. (1998) suggest that they share a consensus on what constitutes suitable learning objectives for a nature of science imbued curriculum. Some specific objectives are that students should understand that:

- Scientific knowledge, while durable, has a tentative character.
- Scientific knowledge relies heavily, but not entirely, on observation, experimental evidence, rational arguments, and skepticism.
- There is no one way to do science; hence, there is no universal step-by-step scientific method.
- Observations are theory-laden.
- Scientists are creative.
- The history of science reveals both evolutionary and revolutionary character.
- Science is the part of social and cultural traditions.
- Scientific ideas are affected by their social and historical milieu.

Notwithstanding this consensus, Schwab's lament, dating from the mid-1960s, that science is taught as an "unmitigated rhetoric of conclusions in which the current and temporal constructions of scientific knowledge are conveyed as empirical, literal, and irrevocable truths" (Schwab 1964, p. 24) remains largely valid even today. In similar vein, Robinson (1998a) echoes ongoing concern at the lack of translation of educational thinking on the nature of science into curriculum and instruction. Given these weaknesses in the practice of science education, it is unsurprising that students develop little sense of what constitutes a good scientific explanation, the relations between causation, inexact laws, and statistical probabilities, theory construction, induction, relativism, and the contested character of science (Rosenberg 2012), these being issues central to *bona fide* science literacy. Robinson (1998b) further suggests that a scientifically literate person bears the following hallmarks:

- Understands the inextricable relationship between the knower and the known.
- Understands the way in which other areas of human thought and beliefs may influence a person's views in science.
- Understands that the aspects of experience of interest to scientists are those that satisfy available procedures for rationalizing data.
- Understands that prediction is possible only when the terms used to express the principles of science have been rendered operational.

In establishing the connection between science and literacy as a lived practice, it is necessary to position scientific endeavor within the broader context of social practice and human culture and not to have students merely learn *about* science. In this spirit, the Legends of Alkhimia game-based learning curriculum was designed and developed to directly engage students in inquiry learning, aligned to ideas set out in Chaps. 2 and 3. This curriculum positions students as authentic scientists engaged in "world construction" and meaning-making processes to construct their personal and justifiable understanding of the chemistry-related regularities that operate in the fictive game world of *Legends of Alkhimia*. The process of scientific inquiry involves students in constructing pertinent questions for inquiry, framing candidate hypotheses that address the questions, engaging in empirical investigations to test the hypotheses, analyzing the data collected from investigations, constructing an explanatory model of the experienced phenomena, and evaluating the robustness of the constructed model. In this manner, students are weaned away from the notion of science as discovery of the hidden truths of nature. Instead, they are drawn into an epistemic culture of science making and into scientific thinking by a community of practice (Knorr-Cetina 1999).

5.1.1 The School Curriculum

The science syllabus for Express and Normal (Academic) stream students in lower secondary school in Singapore is set out in a Ministry of Education document (Ministry of Education 2007). Express stream students sit for the GCE "O" level examinations at the age of 16 after four years of secondary schooling, while Normal (Academic) stream students take five years. Central to the framework for the science curriculum is the notion of "science as inquiry" and "inculcation of the spirit of scientific inquiry" (p. 1). Inquiry is supposedly founded on three domains: (1) knowledge, understanding, and application, (2) skills and processes, and (3) ethics and attitudes. The document further states that "[t]he science curriculum seeks to nurture the student as an inquirer" and that "[t]he teacher is the leader of inquiry in the science classroom" (p. 2).

The aims of the syllabus include:

- Enabling students to acquire understanding and knowledge to become confident citizens in a technological world and to recognize the usefulness and limitations of the scientific method to investigating and solving problems.
- Developing abilities and skills that are relevant to the study and practice of science and encourage safety consciousness and safe practice.
- Developing attributes relevant to the study and practice of science, such as concern for accuracy, objectivity, innovativeness, and critical analysis.
- Stimulating curiosity, interest, and enjoyment in science and its methods of inquiry.
- Promoting awareness that the study and practice of science are cooperative and communicative activities subject to social, economic, technological, ethical, and cultural influences and limitations.

In terms of the specific syllabus in chemistry, as part of a broader general science curriculum that also encompasses physics and biology, the focus is on (a) separation techniques, and (b) chemical reactions involving acids and bases, in the context of scientific inquiry. With respect to separation techniques, the specific aims are that students should:

- Show awareness of basic principles involved in separating techniques involving filtration, distillation, paper chromatography, and use of a separating funnel.
- Explain how the properties of constituents are used to separate them from a mixture through the means of magnetic attraction, filtration, evaporation, distillation, paper chromatography, and use of a separating funnel.

For the properties of acids and alkaline solutions, students should know how to:

- Investigate the effect of a variety of acidic, alkaline, and neutral solutions on universal indicator paper and natural indicators.
- Investigate the effect on universal indicator paper when acidic and alkaline solutions are mixed.
- Investigate the properties of acidic and alkaline solutions, including the properties of acids in reactions with metals, bases, and carbonates.

The requirements above lay down the basis for a sound curriculum in lower secondary chemistry.

5.1.2 Curriculum Challenges

Most teachers who teach chemistry at the lower secondary school level in Singapore recognize that achieving the Ministry's vision of the science curriculum—as laid out in the previous subsection—is a tall order. They readily acknowledge that their teaching practice revolves predominantly around knowledge and skills, while the goals of inquiry learning and values development—specified in terms of ethics and attitudes in the curriculum—get little attention. Given the pervasive school culture of preparing students for common tests across all students at the same level of study, direct instruction, supported by laboratory demonstrations, combined with worksheet completion in the classroom are the most commonly employed teaching methods. For students in lower secondary school, learning science involves "knowing stuff" and being able to apply their understanding at a rudimentary level. Mandatory laboratory sessions in chemistry typically reduce to performing manipulations with laboratory equipment based on the adherence to explicit procedures with the objective of affirming outcomes determined in advance. Consequently, while the learning goals specified in the curriculum are sound and given due lip service, they serve a largely rhetorical purpose in practice. Students have little opportunity to engage in science making, possess shallow understanding of the chemistry they learn (about), and fail to grasp the broader nature and purpose of science and scientific work.

As argued in Chap. 2, however, games-to-learn can offer students the opportunity to actually engage in the *performance* of chemistry through the process of inquiry, rather than merely transacting in language- and symbol-based representations *about* the subject matter of chemistry, including that of scientific inquiry. Given the limitations surrounding teaching and learning practice related to chemistry in schools, the Legends of Alkhimia curriculum discussed in this chapter attempts to shift the focus of student learning from that of third-person spectator to one of first-person actor, thereby transforming the student's epistemic relation to what is learned. In so doing, it seeks to implement a *bona fide* model of inquiry learning and to transform science learning to one based on the professional practice of chemists.

Grounded in authentic inquiry realized through game-based learning, it is hoped that the curriculum will enable teachers to more readily accomplish the Ministry's learning objectives set out for chemistry education in lower secondary schools. Learning designed as a social endeavor among a (classroom) community of inquirers creates a natural space for competing hypotheses and theories to emerge, be critically interrogated, and resolved (even if only partially and tentatively) through communication and dialog, while being always grounded in the (virtual) empiricism afforded by the game *Legends of Alkhimia*. The social learning environment also affords a ready space for the expression and enactment of curricular goals related to the inculcation of students' attitudes, values, and dispositions in science making and for emphasizing that scientific work should be directed toward the pursuit of social good.

5.2 Design for Learning

The Performance–Play–Dialog model of game-based learning, explained in Sect. 3.2, underpins all designs for learning in this book, following the paradigm of games-to-learn. The model is shown in Fig. 5.1.

The Legends of Alkhimia curriculum is rooted in *Performance* pedagogy. It seeks to develop students' enactive capacity to think, speak, act, and value much like professional chemists would. Given the circumscribed curricular focus and limited availability of curriculum time, however, it should not be expected that students who learn with this curriculum will develop the same degree of proficiency or depth of expertise as practicing professional chemists. Rather, the overriding aim is to give students an opportunity to develop the habitus and reflexivity of professional practice, enabled by a first-person access to such practice. In the curriculum, performance is realized through the activities of *Play*—wherein students engage in playing the game *Legends of Alkhimia*—and *Dialog*—wherein students participate in classroom dialog following game play, oriented toward making sense of game play and formulating and interrogating patterns of phenomena observed in the course of play. Through this process, it is intended that students develop not only an understanding chemical behaviors that fall within the scope of

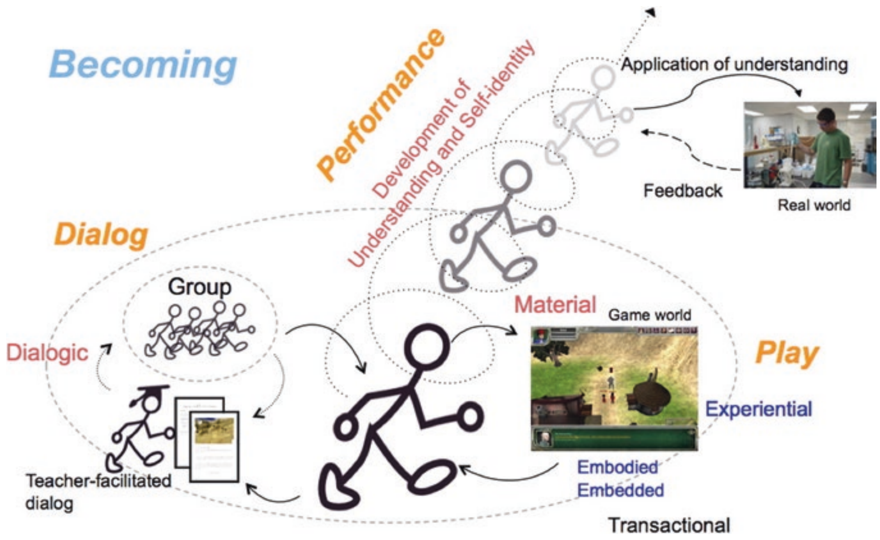

Fig. 5.1 *Legends of Alkhimia* Performance–Play–Dialog model

the curriculum but also a sense of their self-identity, as a scientist-in-the-making, through their conjoint activity of knowing–doing–being–valuing (cf. Sect. 3.3) entailed in the course of performing as apprentice chemists: the role in which the game positions them. The objective is that in so doing, they will *participate* in the science practices of (virtually enabled) real life rather than engage in learning as a preparation for life in some indeterminate future. Consequently, their learning process marks out a trajectory of *becoming* a chemist that is contiguous with life in the real world. In this manner, all talk of the "transfer of learning" is abandoned in favor of an ongoing development of a "history in person" (Holland and Lave 2001). This trajectory of becoming, with the passage of time as a tacit dimension, is denoted in Fig. 5.1 by showing the outline of the student becoming more faint as it projects into the future.

As denoted in the figure, the activity of *Play* takes place in the material world of a local area network enabled computer laboratory that supports multiple groups of four concurrent game players. Students immerse themselves in wrestling with challenges faced by the inhabitants of Alkhimia. As apprentices to a master chemist, they are required to engage in the authentic practices of scientific inquiry to solve the problems faced by Alkhimia's townsfolk. Thus, they are embedded as embodied avatars in the fictive game world of Alkhimia and engage in experiential, first-person learning. Their actions in the game world, as well as their inaction potentially, lead directly to in-game consequences, both positive and negative. In this sense, they are transactionally coupled with the game environment. Each level of game play is associated with a session of teacher-facilitated *Dialog*, wherein students make sense of game play, throw up competing hypotheses pursued during game play, and argue for different theoretical explanations based on evidence gathered in the course of game play. They do all of this while still inhabiting their persona as apprentice chemists. By engaging in the process of information sharing, peer review, and interrogative critique, students mimic the social knowledge construction process that forms the bedrock of professional practice. In this manner, the curriculum's design for learning seeks to foster students' assimilation of a culture of learning predicated on scientific inquiry that extends beyond experimentation.

The design of *Legends of Alkhimia* was significantly influenced by school-related factors. Given the school context, it was considered essential by teachers that each student be required to engage in (virtual) laboratory work individually.[1] Consequently, while students play the game in the 3D game space as co-located players, they encounter the laboratory user interface as if in single player mode, although they are still able to chat with one another via the in-game online chat system when in this mode. In addition, duration of play for each game level had to be proportioned so as not to require more than approximately 30 min. Exceeding this duration would create challenges for teachers to find sufficient time for students to both play the game and engage in the dialogic component of sense making.

Readers should also note that chemistry, as a real-world phenomenon, does not render itself amenable to precise computational modeling. Behaviors such as the intensity of side effects that accompany a chemical reaction or the amount of pressure that an emitted gas will produce are inexact and subject to fine-grained situational differences. For this reason, the simulation of chemical phenomena in the game world of Alkhimia is, of necessity, very much a model of "reality" rather than a replication of it.[2] The level of abstraction chosen for the purpose of modeling is based on attaining a level of fidelity that achieves adequate realism given (a) the objectives of the curriculum and (b) the need to sustain the "magic circle" of game play (Klabbers 2006). A second challenge related to game development concerns the fact that chemical phenomena are but part of a larger complex system that has multiple simultaneous interdependencies. Given the rule-based nature of computational software, it was necessary to simplify the underlying programming logic while, once again, preserving an adequate sense of immersion in a magic circle.

We developed *Legends of Alkhimia* as a game with six levels of game play.[3] Table 5.1 summarizes the topic focus of each game level.

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[1]As a multiplayer game, it would have been possible to adopt a division-of-labor strategy, with the result that not all students need engage with doing chemistry experiments in the virtual laboratory.

[2]Of course, in an absolute sense, game systems are always only models of the world. The issue here concerns the degree of fidelity to the "real" world.

[3]There is also an eight-level variant of the game in which two of the original levels were each subdivided into two parts because it was found, in practice, that these two original levels required more classroom time to complete than was typically available.

Table 5.1 Summary of chemistry topics addressed in each game level

Game level	Chemistry topic
1	Separation of mixture comprising solid particles in a liquid; reaction of acid with metal
2	Separation of mixture using distillation; reactions of acid with metals and bases; factors affecting rate of chemical reaction
3	Acid–base reactions; use of indicators (litmus paper) to test for acidity/alkalinity; effect of soluble and insoluble bases (carbonates) in neutralization reactions
4	Factors affecting rate of reactions (e.g., temperature)
5	Separation of miscible and immiscible liquid mixtures
6	Summary level entailing all of the above

Given that the Legends of Alkhimia curriculum is located in the domain of science and that one of our primary goals related to chemistry education is to foster a deeper, causal understanding of chemical behaviors—as opposed to just having students learn about content—the game was designed with the following guiding principles. First, consistent with pragmatist notions of inquiry learning (cf. Sect. 3.1.2), a person has no other alternative but to bootstrap the learning process by simply, even randomly, trying things out to develop an initial sense of how things work. Consequently, an important design principle was to provide ample support for exploratory learning in the game. This principle was realized in the game by letting players experiment with the weapons they were equipped with to create a space for identifying pertinent cause–effect relations, as well as by allowing them to "mess around" with chemistry equipment found in the virtual laboratory, which they could use in minimally restrained ways including equipment combinations and sequences of use.

Second, we adopted the principle of promoting expectation failure, as advocated by Schank (2002), who drew an important distinction between learning from failure versus learning from expectation failure. The basic premise is that when students take any action in a digital learning environment, they do so with an expectation of the consequence of that action, and actions are taken in sequence to achieve a more distant goal state. However, when executing an action yields an outcome different from what was expected and consequently the pathway to the desired goal state is disrupted, students will realize that their understanding of how things work in the (game) world is fraught with error. In this sense, it might be said that "the world pushes back" on an understanding that is untenable. Expectation failure thus prompts students to reflect on and query their current understanding with a view to identifying what the problem might be and to consider an alternative (hopefully productive) action. This mode of thinking and acting is entirely aligned to Dewey's articulation of inquiry learning and of how we think (Dewey 1933/2008, 1949/1991).

Third, related to the principle of designing for expectation failure is that of designing to expose unconscious assumptions and avoid over-generalizations. The learning issue here is that a sample size of one is an inadequate basis for making a generalization. Yet, the human tendency is to assume all swans are white upon the sighting of a single white swan. To mitigate against this natural tendency, we intentionally sequence students' play experience, so an anticipatable over-generalization arising from playing game level n is deliberately derailed in game level $n + 1$. In this manner, we "force" students to confront the (erroneous) assumptions they make when over-generalizing, and we "push" them to work toward determining the lower level, specific causal factors that are genuinely operative in the modeling of chemical behaviors.

Fourth, *Legends of Alkhimia* was deliberately designed so as to allow students to not only take preferred actions that would yield desirable game play outcomes but also to take multiple alternative (non-preferred) actions that result in negative consequences. I refer to this principle as the "necessity of the negative space for the development of conceptual understanding." Only when students are accorded the opportunity of taking non-preferred (or "wrong") actions can they begin to develop a deep *understanding* of why a preferred (or "right") action is indeed right; that is, it is the correct action that delivers the intended outcome. The positive consequence of this design principle is that it provides students with a first-person, experiential basis—and hence a personal conviction—for asserting why the "right" action is indeed the right one. Put a little differently, this form of experiential learning furnishes learners with the warrants necessary for making their claims. All too often, in formal, school-based learning, teachers focus exclusively on expositing the so-called right knowledge with the consequence that students never understand why "right" is right. It is unsurprising then that students end up only knowing about chemistry rather than developing a deep understanding of this subject. In this context, then, it should be emphasized that human understanding is always *relational*: The notion of "right" can have no meaning except in relation to its antithesis, "wrong," just as the concept of black cannot exist in the absence of its opposite, the concept "white."

At the level of curriculum implementation, we adopted two different models, depending on the extent to which a school's administrators or science teaching staff (head of department and teachers) were willing to commit the time and human resources required to run the curriculum. Thus, the first model treated the Legends of Alkhimia curriculum as part of the school's formal science curriculum. It was executed over a period of four weeks, with two lessons held each week. Of the eight sessions, the first and last sessions were used to introduce the curriculum and to conduct summative tests of learning outcomes, respectively. A survey related to attitudes to science learning was also administered during the first session. The intervening six class sessions were devoted to game play and classroom dialog. For the school that adhered to this model, each session lasted up to 120 min. Some sessions took place during normal school hours, while other sessions took place after normal hours. Although the curriculum was designed for 14-year-olds in Secondary 2, the school that adopted this first model chose to run the curriculum with Secondary 1 students. There was some unease related to parental concern if the curriculum had been run with Secondary 2 students because of an important streaming test for these students at the end of the school year.

The second model positioned the Legends of Alkhimia curriculum as an enrichment program for 15-year-old students in Secondary 3. The teacher who ran the curriculum in this school hoped that the curriculum would contribute to strengthening her students' understanding of chemistry, ahead of the General Certificate of Education "O" level examination that they would sit for in the following year. In this school, the curriculum was run over eight weeks, with one session of up to 120 min held each week after normal school hours. Classroom activities followed the same pattern as that laid out in the first model above.

In both schools, the *Legends of Alkhimia* game was played on Macintosh computers running Microsoft Windows on top of Boot Camp. Somewhat surprisingly, the game ran more reliably under this configuration than on Windows PCs that were available in the schools. Given the limited number of Macintosh computers available in the first school, we arranged for two students to share one computer and to play *Legends of Alkhimia* as a dyad, taking turns to control the computer's mouse. We found that this arrangement was extremely productive for learning. It not only fostered a sense of collaborative learning but also engendered a natural space for science talk (Lemke 1990) as students sought to solve the in-game challenges and make sense of what was going on in the game together. For this reason, we also organized students from the second school in the same way.

5.3 The *Legends of Alkhimia* Game and Game Play

Legends of Alkhimia is a four-person multiplayer PC game that runs in a local area network configuration. It is a Windows software program developed using the Gamebryo® game engine and the ScaleForm software plugin for embedding a 2D interface in a 3D game world. Development was undertaken in-house by the author and his research team.

On first launching the game, the splash screen is displayed (see Fig. 5.2). A designated leader of the game initializes the game session for his team. The remaining three students are then log in and join the designated game session set up by the leader.

When students log in for the very first time, they are requested to create their game character. They can select a male or female avatar and customize its appearance by modifying the hairstyle, hair color, facial expression, skin tone, and color of clothing (see Fig. 5.3). The artwork was designed to be appealing to teenagers.

Once the players create their characters, the game's backstory is presented in the form of a set of timed scrolling slides. The four players, positioned as apprentice chemists, are first briefed by Aurus their master about rumors of strange occurrences in the town of Alkhimia. As they head out to Alkhimia in an aircraft to investigate these strange happenings, it is mentioned that Alkhimia once hosted a laboratory for research on animals. Unfortunately, the experiments went badly wrong. Aurus mentions in passing that he was a party to that research. Unexpectedly, a giant fireball strikes the players' aircraft, and it crash lands in the environs of Alkhimia (see Fig. 5.4).

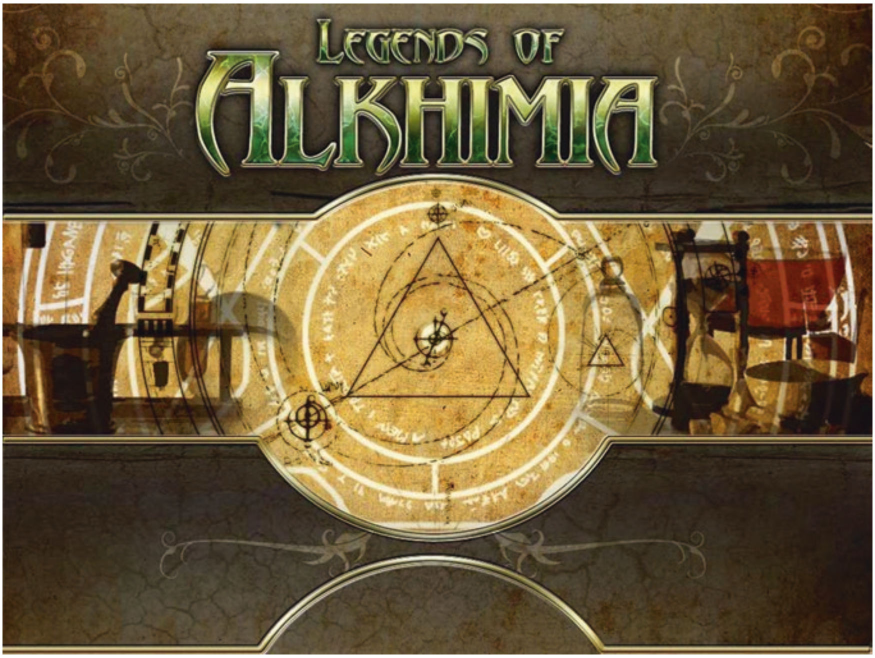


Fig. 5.2 Splash screen of *Legends of Alkhimia*

Fig. 5.3 A player customizing her appearance in the game

Fig. 5.4 Presentation of the game's backstory

Fig. 5.5 Players being attacked by monsters hurling giant fireballs

Level 1 game play commences in this highly situated context. Escaping from the burning aircraft, the players find themselves in a barren and rocky landscape. As they move around and explore the terrain, they are suddenly set upon by a group of monsters that hurl giant fireballs at them (see Fig. 5.5).

Finding themselves armed with weapons, they fire them at the monsters to defend themselves. Unfortunately, their weapons are of limited effectiveness, and they inflict minimal damage on the monsters (strength of −5 shown in Fig. 5.5). Worse still, they find that their weapons jam frequently when being fired, further limiting their ability to defend themselves (see Fig. 5.6). Fortunately for the players, the monsters unexpectedly retreat into the rocky canyons from which they emerged. The players breathe a sigh of relief. They wonder why their weapons were prone to misfiring. Examining their weapons, they find that it consists of an ammunition cartridge slotted into a main body. The cartridge contains ammunition of some kind (which is also depicted visually in the chemical bottles shown on the top-right of the game interface). Aurus hails them through their personal communication device and asks them to teleport to the chemistry laboratory to perform some experiments on the ammunition in the weapons. He suspects that it is composed of some mixture that causes the weapons to jam.

The players duly step onto teleportation plates strategically located in the barren landscape, and they are teleported to the chemistry laboratory. Here, they proceed to their individual workbenches, which then morph into a 2D chemistry workbench with an array of equipment that can be used for separating mixtures. Available apparatus is shown on the left side. Given the hint provided by Aurus, they mess around with the equipment available to see whether they can decompose the supposed mixture into its separate constituents. Figure 5.7 (filtering with

Fig. 5.6 A player's weapon jams while being attacked by monsters

Fig. 5.7 Filtering a mixture using coarse filter paper

coarse filter paper), Fig. 5.8 (simple distillation), and Fig. 5.9 (fractional distillation) illustrate some of the experimental maneuvers possible. (Clearly, the players do not think of what they are doing at this juncture in terms of these descriptions; they are merely messing around with equipment and stuff.) As discussed previously, an open space of playful possibilities is deliberately made available to the players. As they perform the experimental manipulations, the outputs of their laboratory procedures are stored in chemical bottles under the panel labeled "Substances." These substances can later be used as cartridge ammunition.

When the players feel satisfied with what they have accomplished in the laboratory, they can leave the laboratory. Aurus directs them to teleport back to the crash site to see whether they can locate the monsters. The players do so. While wandering around the terrain, they are set upon by the monsters once again. This time, however, they have access to the full complement of unique outputs that they produced while working in the chemistry laboratory to use as ammunition against the monsters. If they use the output of the coarse filter paper (see Fig. 5.7), they find that their weapons jam almost as frequently as before. Unknown to the players, but known to us as the game designers, the original mixture comprised acid mixed with sand, and the sand causes the weapons to jam. Consequently, the coarse filter paper still allows sand particles to pass through. It brings about some improvement, but not much. (Readers with access to Figs. 5.5 and 5.6 in color should be able to observe that the ammunition contained in the chemical bottle comprises a clear blue liquid—fictive acid—with a brown sediment—fictive sand.)

Fig. 5.8 Simple distillation at the chemistry workbench

Fig. 5.9 Fractional distillation at the chemistry workbench

Fig. 5.10 The monsters taking a severe beating

If the players use simple distillation without capping the distillation flask (unlike Fig. 5.8 where it is capped), the acid will boil away leaving them with a solid residue (sand). If they use this residue as ammunition, they will find that their weapons jam constantly. If players use simple distillation or fractional distillation as illustrated in Figs. 5.8 and 5.9, they will, after some time, have two output substances: a brownish residue in the distillation flask (sand) and a clear blue liquid in the conical beaker (acid). These substances are then transferred to the substances inventory shown in the right-hand pane.[4] Once again, the use of sand as ammunition will produce constant weapon jamming. But use of the clear liquid (acid) will lead to the monsters taking a severe beating (damage strength of −100; see Fig. 5.10) and eventual successful completion of the Level 1 game mission (see Fig. 5.11).

There is, however, a subtler learning objective embedded in this game level. It concerns the simplicity and efficiency of separation procedures. The workbench also furnishes players with the use of fine filter paper (second item from top in Fig. 5.7),

[4]Note that, given the level of abstraction employed in designing the game, we do not deal with specific types of acid, for example, sulfuric acid or hydrochloric acid. Hence, coding the color of acid blue should be taken in the spirit of the fictiveness of game play rather than literally. What is important to note, however, is how the clearness of the blue color is intended to signify that the acid is pure.

Fig. 5.11 Mission successful: the monsters are defeated

which allows the same functional goal of effective mixture separation to be achieved more easily compared with the distillation methods. For this reason, separation through the use of fine filter paper is regarded as the preferred solution approach.

Following completion of Level 1 game play, which typically lasts up to 30 min, students engage in dialogic sense making of their game play experience. During this time, teachers interrogate what different student groups did, what they thought was happening in relation to their actions taken and the consequences engendered, and their hypotheses concerning what type of substance the blue liquid might be and why it proved effective against the monsters. A deliberate goal in our pedagogical design, supported by game design and artwork development, was to cultivate students' powers of visual observation in science making. It is not an accident that the monsters appear metallic. The underlying chemistry logic at work here is that acids react with metals and "damage" the metals in the process. Hence, the metallic monsters "take a hit" when struck by acid. In the process of the classroom conversation, teachers take the opportunity to elaborate on the different types of laboratory apparatus that the students played around with, clarifying their purpose and manner of use. But, more importantly, it is the understanding of chemistry that teachers pursue, as they help students grasp the *why* of certain actions and the associated consequences. At the same time, they seek to cultivate the dispositions, values, and modes of thinking associated with professional chemists by highlighting students' specific choices, actions, and classroom discourse as part of their enculturation into a social practice.

Fig. 5.12 Players battling against Level 2 monsters

In Level 2 of *Legends of Alkhimia*, the players receive a desperate plea for help from the townspeople of Alkhimia. The cabbage farms of the town are being razed by groups of marauding monsters hurling giant fireballs and setting the farms alight (see Fig. 5.12).

When the players arrive on the scene, they naturally draw upon substances they previously separated in Level 1 to fight against these monsters. In all likelihood, they will over-generalize their success with the acid ammunition in Level 1 and expect it to be effective in Level 2 as well. If they do so, they find that the previously successful solution now leads to low effectiveness against the Level 2 monsters (damage of −5 shown in Fig. 5.12). Once again, it is not a mere coincidence that Level 2 monsters appear very different from those encountered in Level 1. By design, but unknown to the students, these are now slimy, acidic monsters, and their visual appearance is meant to suggest this idea. This being the case, it is unsurprising that using acid as ammunition against acidic monsters has low efficacy. The observant player will, however, notice that Level 2 furnishes an additional type of substance beyond those encountered in Level 1. This substance, visible in the pane on the right side of Fig. 5.12, consists of iron filings. (Again, this "fact" is known to us as game designers but not known to students at the time of play.) First encountered in the laboratory as iron filings in water, players must first separate the filings from the water using a magnet (see Fig. 5.13). When a student attempts, in the spirit of playful exploration, to use this new ammunition

Fig. 5.13 Grinding iron filings into iron powder

against the monsters, she will find that it is fairly effective. This development allows players, as a team, to gain some traction in repelling the acidic monsters. But, more importantly, deeper questions inevitably arise. Students will wonder: What is going on here? Why did the previously successful ammunition not work against these particular monsters? Is something different? What is it that is different? This state of cognitive dissonance primes students for the dialogic portion of the class session that will ensue. However, if players are diligent with their laboratory work, they will find a mortar and pestle in the Level 2 laboratory that allows them to grind the iron filings into powder form. Only by using iron powder as ammunition against the slimy monsters will players finally accomplish the mission of defeating the Level 2 monsters. In the dialog that follows, teachers challenge students to make sense of what took place in Level 2 and why grinding filings to powder results in a more potent outcome. (The reason is iron powder affords greater reactivity with acid compared with iron filings.) In this manner, students are invited to hypothesize about the nature of chemical substances, search for evidence to support their claims, and construct a coherent and warrantable set of assertions concerning the properties and behaviors of the substances they encounter, including the new substance (iron filings).[5]

[5]While we, as designers, think of the substance as iron filings, in practice, any substance with like properties is also acceptable as a speculative substance that students may suggest.

Fig. 5.14 Cabbages in the cabbage patch have changed from green to red

Level 3 of the game opens with the townspeople of Alkhimia finding, to their horror, that cabbages in their cabbage patch where the slain monsters had lain and rotted away in the hot sun are now no longer green in color but a stark red (see Fig. 5.14). It appears that the waste of rotting monsters, and possibly the stuff fired from their weapons as well, has contaminated and transformed the cabbages. The players are tasked to solve this problem for the townspeople by returning the cabbages to their original state. They must find an antidote substance that they can spray on the red cabbages to turn them back into green cabbages. Players revert to the laboratory with samples of monster waste and red cabbage leaves to find a solution. In the laboratory, they find additional substances, which are for us, as game designers, surrogates for soluble as well as insoluble hydroxides and carbonates. All of these substances are alkaline.

Players place a cabbage leaf (surrogate for litmus paper) and some monster waste (which is acidic, thus turning the cabbages red) in a flask. They experiment by adding, among other possible substances encountered in previous game levels, these four new substances. It turns out that if they add a soluble carbonate or hydroxide, the cabbage leaf in the flask turns blue (indicating alkalinity) after turning green for a short period of time (indicating transition through a neutral state that is neither acidic nor alkaline). The critical difference between the two observed chemical reactions is that a gas is also produced in the gas syringe with a carbonate–acid reaction but not with a hydroxide reaction. Players are likely to

Fig. 5.15 Adding an insoluble carbonate turns the cabbage leaf purple

be perplexed when this happens because they can now turn the cabbage leaves blue but not green, which seen momentarily, feels very elusive. It is only if they use (sufficient) insoluble carbonate or hydroxide, or iron filings or powder from Level 2, that the ensuing chemical reaction will yield a salt and water, and a purple (to suggest a color mid-way between red and blue, and hence neutrality) cabbage leaf, which is the outcome they need (see Fig. 5.15). If students then use one of these substances as ammunition and spray it (by shooting their weapons) over the red cabbages, the cabbage patch turns green and the townspeople come forth to express their appreciation of the players' efforts. The many substance combinations possible in this game level, together with the complex chemistry of acid–base reactions involved typically lead to extended sense-making dialog in the classroom.

In Level 4 of *Legends of Alkhimia*, students are sensitized to the effect of differences in temperature on the rate of chemical reactions. The level opens with the players located on a snowy mountain top where the now-familiar green (acidic) monsters first encountered in Level 2 set upon them with renewed vengeance. Once again, it is likely that players will expect their previous solution of iron powder to be effective against these monsters in this new situation. But, alas, that is not meant to be. The old solution is now found to be barely effective. The players beat a hasty retreat, puzzled by the latest development, and return to the laboratory. Here, they find a water bath in which they can test their chemical reaction.

Fig. 5.16 Battling against dragon turtles in the lava pit

The temperature of the reaction can be lowered by adding ice to the water bath or raised by heating the water. A virtual thermometer indicates the temperature reading of the experiment. Completing the laboratory work, the players teleport back to the mountain top. Level 4 provides a new interface element, which players may soon notice (shown below the chemical substances panel on the right side). Selecting this button, they find that a heating element is attached to the nozzle of their weapon. When the acidic monsters reappear and players fire their weapons with the heating element attached, they find that their ammunition of iron powder is very effective once again. They will likely wonder why. Aurus soon instructs them to teleport to a disused lava pit at the base of the mountain where fresh monster sightings have just been reported. Players hasten to the lava pit. There, they encounter dragon turtles that swarm around them. A player is killed if a dragon turtle bumps into him. These turtles can only be destroyed if fired upon, while a fiery wheel spins around them (see Fig. 5.16).

If players fire their weapons with the heating element still attached from the mountain top episode, they may destroy a dragon turtle, but they will also kill themselves in a giant fireball. (Fortunately, the game will respawn the player who killed himself after a penalty time-out period.) It is clearly very hot in the lava pit. Hence, using the heating element results in an immediate explosion regardless of the type of ammunition loaded. However, when students remove the heating element from their weapon nozzle, they are able to engage in a hefty battle

Fig. 5.17 Players trapped in the disused underground laboratory

with the dragon turtles—and, with due effort, win. In this manner, the game design employs the strategy of situational stepwise refinement to help students discriminate between the critical variables that are operative in each game setting and to prevent them from constructing causal rules that are over-generalized.

As players try to make their way out of the lava pit at the opening of Level 5, they find themselves in a disused underground laboratory with a locked heavy metal door that prevents them from getting to the surface. Peering around in the dimly lit laboratory, they find quaint bottles containing two types of liquids: one that is composed of two distinct layers and the other that appears homogeneous. A noxious gas begins to sleep slowly into the laboratory as a digital timer begins to count down. Through their communication device, Aurus suggests that they try separating the liquids in the hope of finding a pure liquid that they can fire at the metal door such that, with the aid of the heating element attached, they can melt a hole through the door and escape (see Fig. 5.17).

From the perspective of chemistry (and unknown to the students), there are actually two types of liquid mixtures. The first mixture comprises immiscible liquids—water and oil—with different densities, such that one floats above the above. The second mixture comprises miscible liquids—water and ethanol—such that both blend into a homogenous whole. The players work rapidly under the constraint of time to separate the mixtures. If they fail to escape before the count down timer runs out, the noxious fumes knock them all out. (Fortunately,

Table 5.2 Summary of game levels

Game level	Game context
1	Metallic monsters encountered at crash site. Weapons jam because acid ammunition is mixed with sand
2	Acidic monsters encountered among the cabbage fields of the Alkhimian townspeople. Old ammunition no longer works. Iron powder has higher reactivity against monsters compared with iron filings
3	Acidic monsters contaminate the cabbages upon decay. Players must neutralize the contamination by finding a suitable neutralizing agent
4	Players encounter acidic monsters on the mountain top and dragon turtles in the lava pit. Different temperatures affect the rate of chemical reaction
5	Players are trapped in a disused underground chemistry laboratory. They must successfully separate miscible and immiscible liquid mixtures to escape
6	Grand finale that recapitulates all the preceding challenges

they will be respawned.) To succeed, players can use fractional distillation to separate ethanol from water—ethanol will boil off first because it has a lower boiling point—or they can use a separating funnel to separate water from oil—water, having higher density, will flow out of the funnel first. Armed with pure ethanol or oil and aided by the heating element, students can then shoot at the door and burn a hole through it to escape.

Level 6 of *Levels of Alkhimia* is a summary level. It recapitulates on all the chemical reactions, and the factors that affect the rate of reaction, that players experienced in the preceding five game levels. This level thus serves to review and consolidate the chemistry addressed in the entire game-based learning curriculum. For ease of reference, Table 5.2 summarizes the six levels of the game.

It is reiterated here that in keeping with the paradigm of games-to-learn advanced in this book, *Legends of Alkhimia* does not furnish direct instruction in chemistry. The dialogic sense-making conversations that follow game play are a critical component of the curriculum's overall pedagogy and of equal importance to game play. The game per se is but a technological artifact for instantiating a process of scientific inquiry. Through the dialogic classroom conversations, a discourse space is created for competing claims to emerge, collide, and be rebutted, alternative suppositions and speculations to be voiced, a wide array of evidence to be cited in defense of assertions made, and contradictions in argumentation to be identified. Teachers have the important role of facilitating the classroom dialog and modeling the interrogation and probing of knowledge claims in the "public" arena. They also have the responsibility of helping students rise above the level of specific details to distill defensible claims into more general theoretical statements. At the same time, they guide students to understand the pragmatic and functional character of science making—that there may be multiple solutions to a given problem with some solutions being regarded as better than others and why—as well as the values that undergird choices in science making—for example, parsimony and generalizability of theory and a preference for efficient and less costly solutions.

From the perspective of performance theory, students' participation in both play and dialog constitutes a performance of their becoming-chemist (Semetsky 2006). Given the more public, and hence visible, nature of classroom dialog, what students say and do during these sessions—their performance—provides rich opportunities for evaluation of student learn*ing*—that is, learning as a process—including the attitudes, values, and beliefs that students hold. A summative assessment can also be administered, of course, at the conclusion of the learning process, and Sect. 5.4 shares an instance of such an assessment. Learning chemistry through inquiry, which necessitates the repeated coupling between action and reflection in situated problem-solving contexts, students develop the habitus that Bourdieu speaks of (Bourdieu 1977; Webb et al. 2002). Like the expert basketball player, they learn to think–act on-the-fly and in a seamless manner in the problem domain (Calhoun 2003). They develop what Dewey (1922/2008, p. 124) referred to as a kind of knowing that "lives in the muscles." They come to know chemistry performatively rather than merely know *about* chemistry.

5.4 Student Learning Outcomes

Unlike the research on the Statecraft X curriculum, which benefitted from two cycles of research funding, research on the Legends of Alkhimia curriculum was funded through a single research grant. As this grant subsumed design and development work on the game, classroom testing was limited to two schools. The curriculum was run twice in the first school in 2010, producing good results. One set of outcomes from this school has been reported in Chee and Tan (2012). Findings from the research showed students' positive attitudinal shifts with respect to identity as a professional scientist and inquiry learning in science. In addition, a summative posttest comparing the intervention class comprising 13-year-olds with a control class showed a statistically significant difference on test scores in favor of the intervention group. The administered test is shown in Fig. 5.18.

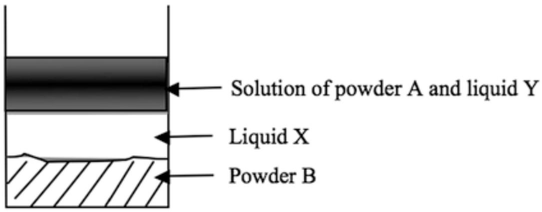
Here, I share the result of the summative posttest administered at the conclusion of the intervention in the second school, which was for boys only. This intervention took place over the period January to March 2011. The context of this intervention was quite different from that of the first school. In the second school, a female chemistry teacher ran the Legends of Alkhimia curriculum with a group of 15-year-old students as part of an enrichment program held after formal school hours. The students were participants of the school's science talent program for Secondary 3 students. The curriculum was run as an eight-week program, with one session held each week. Each session lasted up to two hours except for the last, which lasted one hour. The play–dialog sequence was followed in each lesson. However, given the aims and concerns of the teacher concerning the enrichment context, she added a component of live demonstrations of chemical reactions pertinent to the various game levels in the computer laboratory as a means for seeking lesson closure given the topical focus of each session.

Chemistry Post-test

Task A

You need to separate a mixture containing four components. The four components are liquid X, liquid Y, powder A and powder B.

Liquid X is denser than, and immiscible in, liquid Y.
Powder A is insoluble in liquid X but dissolves in liquid Y to form a solution
Powder B is insoluble in, and is denser than, liquid X and liquid Y.



Design an experiment to separate the mixture into its four components.
Draw diagrams to illustrate your procedures and explain why your experiment will be effective in separating the mixtures.

Fig. 5.18 The summative posttest on separation of four-component mixture

Given the enrichment program context, it was not possible to compare summative test results of the enrichment class with a control class, because there was no other enrichment class that might serve as a comparable control. Being alerted to this in advance, we opted to administer the chemistry assessment as a pre–posttest instead. Hence, the test, shown in Fig. 5.18, was administered during the first session and again after the last session.

As can be seen, the test problem comprises a complex separation of mixtures task. It was designed by a science education professor who was a member of the research team. The test assesses two aspects of students' understanding: (1) effectiveness of separation achieved and (2) conceptual understanding of chemistry demonstrated in students' written answers. The said science education professor and a research fellow scored students' responses based on a predetermined scoring rubric. The maximum separation score available was 8, and the maximum concept score attainable was 6.

On the criterion of effectiveness of separation of mixture, the pretest mean was 4.38 ($SD = 2.31$) and the posttest mean was 6.10 ($SD = 1.92$). A paired samples t-test yielded the result $t_{28} = 3.69$, $p = 0.001$. On the criterion of conceptual understanding, the pretest mean was 4.24 ($SD = 1.64$) and the posttest mean was 5.10 ($SD = 1.05$). The paired samples t-test yielded $t_{28} = 2.95$, $p = 0.006$. Thus, it can be seen that the improvement in scores was statistically significant for both assessment criteria.

5.5 Reflections on the *Legends of Alkhimia* Chemistry Curriculum

In closing this chapter, I take the opportunity to share some striking observations that arose in implementing the Legends of Alkhimia curriculum in the hope that readers might have a concrete sense of some deep-seated challenges to enacting a *bona fide* science inquiry curriculum in schools.

First, students have deeply entrenched epistemological beliefs that run against the grain of the purpose and value of inquiry. I interviewed several students after the curriculum wrapped up in the second school referred to above. One student was asked whether the curriculum had affected his understanding of science in any way. He replied that it had not changed much "because I am more of a factual person, so I like to memorize stuff and that's my strong point in science." When probed further on what he meant by describing himself as "a factual person," he said, "Because I usually would like to find out the correct answer because if I try an experiment and the reaction is wrong, I may remember the reaction wrongly and that will not aid in my science learning."[6] These excerpts are indicative of the student's understanding of science education as (1) constituted by the learning of facts, something he sees himself being good at and (2) a fixation on "correct" versus "wrong" in the learning of science and the consequent fear that exposure to a "wrong" answer may confuse him and lead to him memorizing the wrong answer instead of the right answer. Although not explicitly stated, the student's response is highly indicative of an objectivist ontology: A scientific account of the natural world predicated on objects with fixed properties that are fortuitously "discovered" by scientists, namely the "facts" of the world.

Another student was adamant that the Legends of Alkhimia curriculum entailed too much unnecessary time and student effort in playing the game and dialoging to make sense of what was going on. He insisted that "all knowledge is on the Internet." Hence, it would be simpler for him to search the Internet to find out anything he did not know. It is indeed ironic that students identified by the school as being talented in science adhere staunchly to viewpoints antithetical to science educators' conceptions of what constitutes an effective science education.

Second, a large part of the dilemma with students' science understandings may arise from teachers themselves being ontological objectivists and conceiving the domain of science as constituted by discovered facts that take on the standing of "scientific truths." In my interactions with chemistry teachers, including those supportive of inquiry learning, I constantly encounter strong resistance to framing learning in terms of becoming-chemist. Unlike social studies teachers in the Statecraft X curriculum who readily embrace the curriculum objective of

[6]In the context of how local students speak and what they mean, it should be clarified that the student was referring to obtaining a non-preferred chemical reaction when he used the phrase "the reaction is wrong," and to remembering the non-preferred reaction as the preferred one when he used the phrase "remember the reaction wrongly."

becoming-citizen, many science teachers manifest a proclivity to positioning "scientific knowledge" as constituted by "proven" truths and facts and emphasizing the discourse of objectivity, measurement accuracy, and reliable (human) observation that is replicable regardless of context. Learning to think and act like a chemist feels foreign to chemistry teachers. While outwardly professing to be "good constructivists" from an epistemological perspective, they remain closet objectivists from an ontological perspective: a self-contradictory and non-tenable position with respect to onto-epistemology (Barad 2007).

In addition to the aforementioned deep-seated issue, chemistry teachers also wrestle with the practical challenges thrown up by the conventional classroom context. Effective inquiry learning typically requires more time than what is customarily available for direct instruction, but it also yields outcomes that extend far beyond "knowing stuff." Expressed differently, inquiry learning constitutes a different means to a different set of ends, including robust understanding and a capacity for performance. Such benefits do not come for free. Teachers whose onto-epistemological beliefs are problematic are likely to feel that all the time spent in dialog and talking science (Lemke 1990) is needless and a waste of time, especially when standard forms of teaching chemistry (content) and assessing for content do not require it. Consequently, both curricula requirements and approaches to assessment of learning stand in need of reform. In a culture of international benchmarking, reductive assessments, and excessive valuation of "objective measurement," there continues to be significant resistance to such reform (Biesta 2010).

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Chapter 6
Escape from Centauri 7: Reifying Electromagnetic Forces Through Simulation

The previous chapter addressed students learning chemistry at the lower secondary level. This chapter focuses on game-based learning in the realm of physics for students at the upper secondary level. Singapore students who take science at this level typically sit for the General Certificate of Education (G.C.E.) "O" level examination administered locally in conjunction with the Cambridge International Examinations Board. We designed and developed a game-based curriculum that deals with electromagnetism to allow 15-year-old students to learn electromagnetism by participating in a scientific inquiry process so as to understand the social construction of reality (Berger and Luckmann 1966), as part of their science education.

6.1 Learning Electromagnetism

The curricular objectives of the G.C.E. "O" level science syllabus (MOE & UCLES 2013) are noteworthy in that they make only passing reference to inquiry. Worse yet, inquiry is cited only as a possible exemplar that may be given consideration by teachers in connection with the aim of developing "attitudes relevant to science" (p. 2). Consequently, inquiry is lumped together with quite a few other desirable attitudes: accuracy and precision, objectivity, integrity, initiative, and inventiveness. Little wonder, then, that the development of inquiry is given scant attention by schoolteachers who focus on helping students ace the "O" level science examination. The end result is that students leave school with little understanding of the nature of science (cf. Sect. 5.1) and lacking basic literacy in scientific inquiry.

The physics component of the science curriculum positions electromagnetism as an advanced topic because it is predicated upon sound prior understanding of

Y.S. Chee, *Games-To-Teach or Games-To-Learn*,
Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_6

Newtonian mechanics, including force and motion, and electricity. Standard physics textbooks often introduce the subject matter in a rather abstract and mathematical way. Serway and Beichner (2000), for instance, introduce the concept of an electric field in the following manner:

> [A]n electric field is said to exist in the region of space around a charged object. When another charged object enters this electric field, an electric force acts on it…. The electric field **E** at a point in space is defined as the electric force $\mathbf{F}_e$ acting on a positive charge q_0 placed at that point divided by the magnitude of the test charge: $\mathbf{E} \equiv \mathbf{F}_e/q_0$. (pp. 718–719)

Unsurprisingly, students find this description difficult to understand. What appears necessary is to find some way to concretize the idea of an electric field. The idea is rendered more opaque by the fact that an electric field is represented by the vector **E**, indicating that it possesses magnitude as well as direction. Given the three-dimensional nature of this phenomenon, immersive 3D environments can be extremely useful in helping students grasp the dimensional and directional aspects of the phenomenon under study. The *Escape from Centauri 7* game-based curriculum leverages on the 3D affordance of immersive game spaces to aid students in developing an intuitive and embodied sense of electromagnetism, as well as to engage them in the process of scientific inquiry and the construction of scientific knowledge.

6.1.1 The School Curriculum

The science curriculum that leads up to the G.C.E. "O' level examination is taken by Express stream students who complete secondary education in four years. The objectives of the curriculum comprise three components described as (1) knowledge with understanding, (2) handling information and solving problems, and (3) experimental skills and investigations (MOE & UCLES 2013). Item (1) requires students to demonstrate knowledge and understanding of scientific phenomena, facts, laws, definitions, concepts, theories, scientific vocabulary, instruments and apparatus, scientific quantities and their determination, and applications. For this item, the syllabus states that "[t]he subject content defines the factual knowledge that candidates may be required to recall and explain. Questions testing these objectives will often begin with one of the following words: *define*, *state*, *describe*, *explain* or *outline*" (p. 3). Readers will quickly recognize that this component invites, and indeed requires, extensive content memorization. Curiously, the examination committee appears not to perceive that memorization and recall neither entail nor require understanding.

Item (2), related to handling information and solving problems, requires that students be able to (a) locate, select, organize, and present information from a variety of sources, (b) translate information from one form to another, (c) manipulate numerical and other data, (d) use information to identify patterns, report trends, and draw inferences, (e) present reasoned explanations for phenomena, patterns, and relationships, (f) make predictions and hypotheses, and (g) solve problems. Here, some degree of understanding is indeed needed. However, it is also stated that "[i]n answering such questions candidates are required to use principles and concepts that are within the syllabus and apply them in a logical, deductive manner to a novel situation. Questions testing these objectives will often begin with one of the following words: *predict*, *suggest*, *calculate*, or *determine*" (p. 3). The statement's construction hints at the embracement of Bloom's taxonomy (critiqued in Sect. 2.2.3), because it suggests that principles and concepts must first be comprehended, then applied to solve some problem. While the terms *predict* and *suggest* invite more open-ended thinking and speculation, *calculate* and *determine* clearly indicate the application of deterministic procedures to closed problems. We can thus infer what kind of problem solving the examiners envisage by virtue of the descriptors used. Item (3) represents a separate assessment category that deals with the laboratory-based practical examination.

The science syllabus states that item (1) carries 50 % of the subject's assessment value, with approximately 20 % allocated to recall of factual information. Item (2) accounts for the remaining 50 % of assessment value. From the foregoing, it is evident that the syllabus is biased in favor of content and knowing *about* science rather than knowing science that comes through doing science. Consequently, the "O" level science syllabus succumbs to Lemke's (1990) criticism that schooling systems are preoccupied with having students consume ready-made science rather than helping students learn science by doing science.

6.1.2 Curriculum Challenges

Assuming that one is prepared to largely disregard the express requirements of the above-mentioned syllabus and wishes to foster students' inquiry skills and deep understanding of electromagnetism, it will soon be recognized that this subject domain is challenging to grasp because electrical and magnetic fields are non-visible and non-intuitive phenomena. Located within the broader locus of scientific constructs created for explanatory purposes, the notion of non-contact forces-at-a-distance that acts through space can feel disconcertingly odd initially. Furthermore, electric and magnetic fields are three-dimensional in nature, and understanding how such fields impact the behavior of charged particles traveling through their loci requires an inherently spatial sense of the phenomena. Consequently, students need to develop an embodied sense of electric and magnetic fields and acquire an instinctive "feel" for the phenomena with their bodies.

It is fortunate that the affordances of immersive game worlds readily support development of this embodied and spatial sense of electric and magnetic fields. Such digital environments further allow the use of visualization techniques to render that which is non-visible in the real-world visible in the simulated game world. Thus, electromagnetic forces can be reified and given concrete form in an immersive game environment. This visualization aid can scaffold the learning process until such time when students have developed the embodied intuitions needed to understand the said phenomena.

6.2 Design for Learning

The design for learning adopted in the Escape from Centauri 7 game-based curriculum is consistent with that employed in the Statecraft X curriculum (described in Chap. 4) and the Legends of Alkhimia curriculum (described in Chap. 5). The design for Escape from Centauri 7 is shown in Fig. 6.1.

As before, the curriculum instantiates a performance pedagogy constituted by the dialectic relation between play and dialog. Competence in science inquiry is developed through students' performance of inquiry as they advance through the game-based curriculum. Concomitant with the pursuit of inquiry, engagement with the curriculum develops students' scientific understanding of the subject domain, namely electromagnetism.

Students immerse themselves in the virtual world of Centauri 7 through the activity of play. The game embeds them in the digital terrain of the fictional planet Centauri 7. By virtue of this embedding, students project their embodied selves into the game world. Engaging in the problem-solving challenges presented by the game world, students learn experientially—through doing—in the first person. Consequently, they do not merely learn *about* inquiry and electromagnetism.

Escape from Centauri 7 comprises a 10-level series of puzzle games that simulate electromagnetic phenomena. It requires students to overcome challenges related to the predicament of having crash-landed onto the planet Centauri 7 because of their space craft's engine breakdown. Not all levels of the game were used in our research, however, due to limited time that school administrators made available to administer the curriculum. Consequently, the implemented curriculum typically consisted of eight 90-min sessions held in a computer laboratory that supports setting up of the multiplayer game on a local area network.

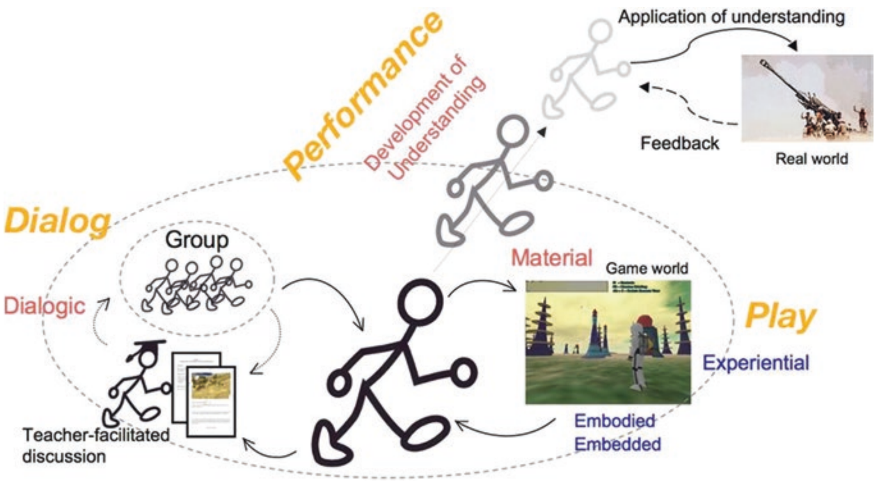


Fig. 6.1 *Escape from Centauri 7* Performance–Play–Dialog game-based learning model

Our customary arrangement was to have groups of three students participate collaboratively in a cluster of three networked PCs, with one PC hosting the game locally. Over the course of the implemented curriculum, students would play Levels 1–6 and Level 10—the grand finale—of the game. In so doing, they would explore the behaviors of positively and negatively charged particles as they travel through both vertical and horizontal fields that are induced by electric as well as magnetic forces. Regrettably, students usually did not get the opportunity to experience the phenomenon of point charge fields that direct charged particles into a circular path.

Game play sessions are followed by dialogic sense-making conversations. For the Escape from Centauri 7 curriculum, dialogic sessions were designed to take place at two distinct levels: that of the game play group and that of the whole class, where student groups were invited to present their current findings to all students in the class. Students were furnished with exploration logs, a form of scaffolding, which guided their inquiry for each level of game play (see Fig. 6.2). Their objective was to compile their accumulated logs into a composite log file

Exploration Log 3: Generalising patterns of behaviour

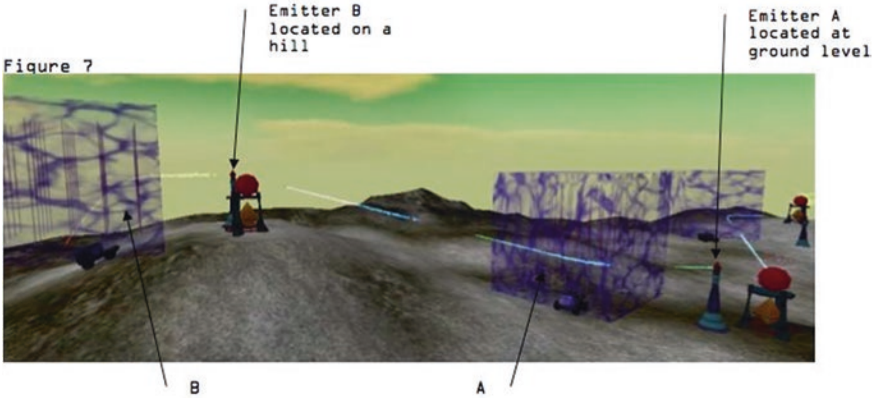
Log entry by (Team) Date

At every reconnaissance we conduct we uncover new phenomena or new aspects of the same phenomenon. We found ourselves modifying our hypotheses as we go along. For example, just when we thought we had figured out the behaviours of the particles, they start behaving in a way that goes against our expectations.

Scenario 3

Figure 7 shows a sky-cam shot of a situation encountered at Tergis. The behaviour of the particles in the regions labelled "A" and "B" is different even though the same type of field and similar field strengths are used. The field is directed downwards towards the ground in both regions. In this situation, particles from Emitter A travel towards the left to hit the generator powering Emitter B.

Figure 7



(a) How do I explain the difference in behaviour of the particles at "A" and "B"?

Fig. 6.2 Example of exploration log for Level 3 of the game *Escape from Centauri 7* that they could leave on the planet after (hopefully) being rescued from Centauri 7. Thus, the composite log files document students' inquiry-based findings and group-constructed understandings of the electromagnetic phenomena encountered on the planet. In effect, then, the composite log files constitute a group-authored textbook, and this concrete product of the learning process was used as the basis for assessment of student learning. As a consequence of the deep understanding that this inquiry curriculum engenders, it is hoped that students' understanding will transition directly into an understanding of real-world manifestations of electromagnetic phenomena due to the trajectory of their learning being "in person" (Holland and Lave 2001); that is, because learning took place as a first-person experience. Consequently, the notion of "transfer" of learning—a deeply problematic notion (Packer 2001)—is jettisoned.

6.3 The *Escape from Centauri 7* Game and Game Play

Escape from Centauri 7 is a simulation game that supports four modes of game play: (1) Story mode, the mode that is used for the school-based curriculum, (2) Time Attack mode, which introduces a time limit within which a game level must be successfully accomplished, (3) Sand Box mode, which allows students to freely explore the mechanics of game levels, and (4) Team Battle mode, which allows two teams of players to pit their skills against each other.

On selection of the "Story Mode" button, players are asked to log in. Upon the first log in, students are presented with a movie clip that introduces the backstory of the game. It is the year AD2245. The player and his team of space explorers are on a spacecraft approaching the mysterious planet Centauri 7 to investigate the first evidence of alien life that has been reportedly found. Unexpectedly, an asteroid strikes their craft (see Fig. 6.3), and it crash-lands on the planet. Their overall mission is thus to escape from Centaur 7. To accomplish this goal, they must find a way to fire a coil gun, which they discover on the planet, to send a message to their fellow space explorers informing them of their plight and requesting urgent rescue from the planet.

Students are presented with the game's world map, which depicts the sites that provide access to the 10 game levels (See Fig. 6.4). Following the Story mode sequence, students gain access to the game levels incrementally while being always able to gain access to previously completed levels. Each level kicks off with a mission briefing. As indicated by the map, students must progress through the sequentially connected game sites, powering up the dormant electric generators they find in each site, until they arrive at the final destination, Ducat. There, based on their aerial surveillance, they have found a giant coil gun that will allow them to send a message to their fellow space explorers in outer space, provided they can get all the generators working to provide the electrical power needed to fire the gun (see Fig. 6.5).

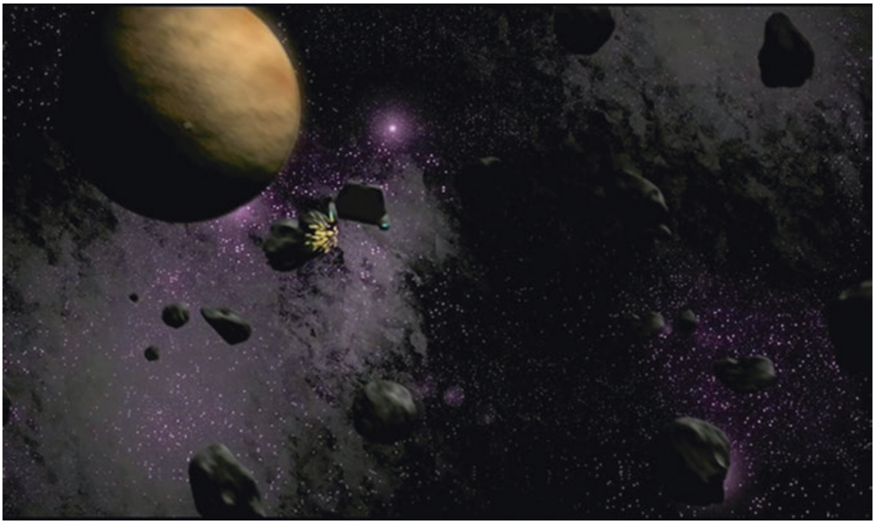


Fig. 6.3 Snapshot from the introductory movie showing the spacecraft being hit by an asteroid

Fig. 6.4 The world map of *Escape from Centauri 7*

Fig. 6.5 Giant coil gun on the island of Ducat surrounded by particle generators

Commencing from the valley surrounded by mountains in the region of Intrux (Level 1) where the space explorers crash-landed, players find themselves surrounded by strange devices. Being the first game level, tutorial help is built-into bootstrap game play. Thus, the players are initially furnished with explicit initial goals, such as that of activating the blue dome power transmitter, and they are urged to investigate the alien devices at the site, shown in Fig. 6.6. By this means, players soon learn how to activate the strange looking stationary devices found scattered around the undulating terrain (see Fig. 6.7) as well as how to deploy mobile vehicles, such as a terrain buggy that allows them to traverse the terrain and set up electrical and magnetic fields (see Fig. 6.8). The introductions to these devices serve as a learning scaffold, and they sensitize players to the fact that these devices can deploy and un-deploy "fields" of some kind (as indicated in Fig. 6.8), although it is not evident to students at this point in time what is meant by this term. Rather, it is through the inquiry process that students make sense of what is meant by the term, as well as the behaviors of different types of fields. Inter-player real-time communication appears in the chat box shown on the top left corner of the screen.

As illustrated in Fig. 6.7, particles that get deflected into the mountainside have no efficacy for game play. Thus, students are challenged to position and utilize a combination of stationary and mobile field-generating devices to fire up a chain

Fig. 6.6 Initial guidance to game play is furnished by tutorial help

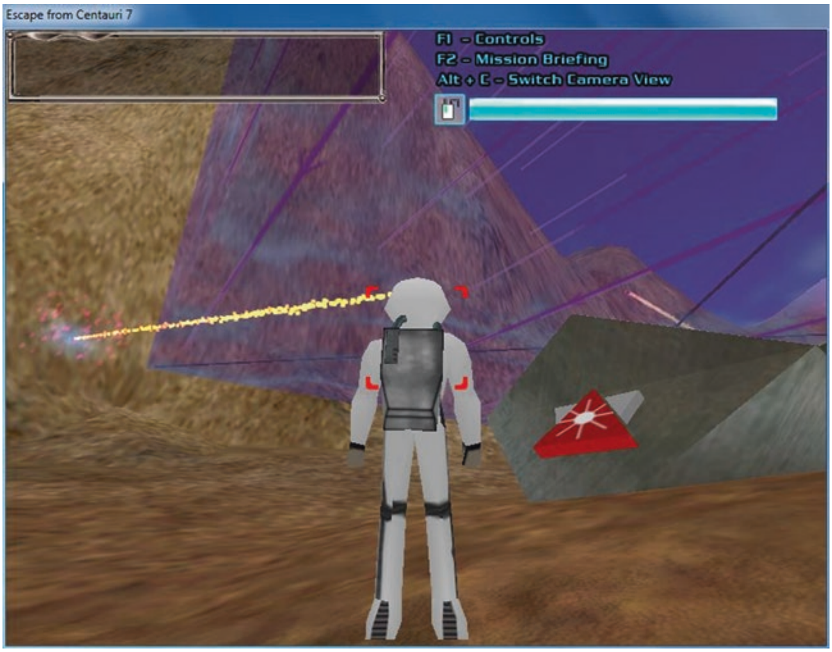


Fig. 6.7 Player experimenting with the stationary field-generating device

Fig. 6.8 Introducing players to the mobile buggy that can deploy and un-deploy "fields"

of electric generators. Each generator is coupled to a particle-emitting tower. Activating a generator provides the power needed by the tower to emit charged particles. The goal, then, for Level 1 is to ensure that the final particle exiting from Intrux enters the terrain of Tulen, the next level of the game, where it can then be further redirected.

Figure 6.8 shows how a deployed field has the attributes of strength and direction. Level 1 focuses on horizontal electric fields (depicted in Figs. 6.7 and 6.9). In this game level, the particles are positively charged, and their trajectories are depicted with a color trail, coded in orange. Players set the strength and direction of the field by the extent to which they drag the indicator to the right or left (see Fig. 6.8). The greater the extent to which the indicator is dragged to the right or left, the greater the strength of the field. If the indicator is dragged to the right, the positively charged particles are deflected to the right in a parabolic path (see Fig. 6.9) and vice versa. Thus, players can modify the trajectory of a moving particle stream by strategically positioning field-generating devices in the path of the charged particles.

Players can switch the game's camera view between a third-person view of the world (that is, with the 3D camera positioned behind the player as shown in Fig. 6.9) and a first-person view (with the world as seen through the eyes of the virtual player and no representation of the player shown in the game world as shown

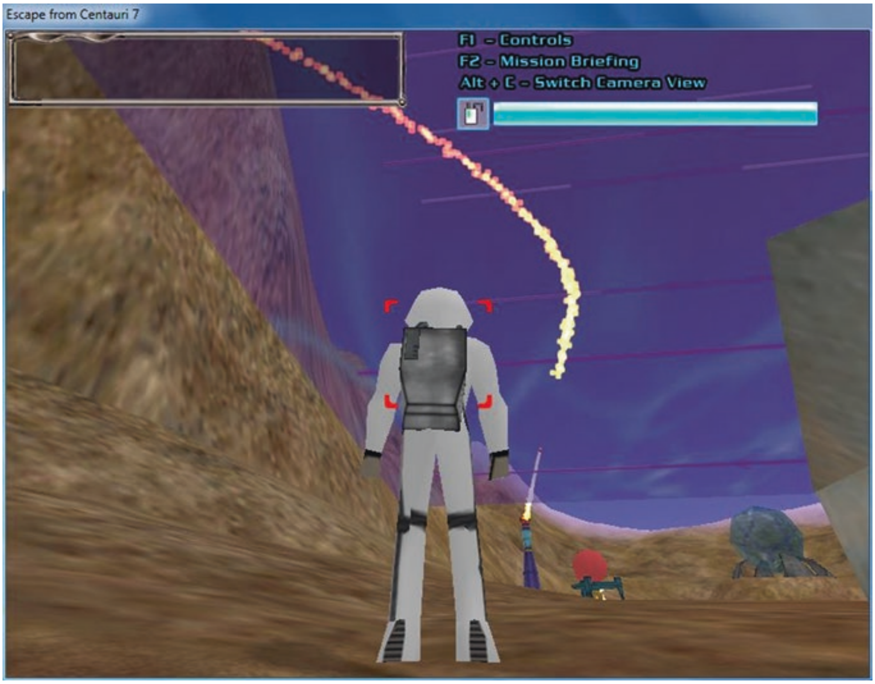


Fig. 6.9 Deflecting a charged particle to the right by means of a horizontal electric field

in Fig. 6.5). In addition, players are equipped with a jet pack harnessed onto their (virtual) backs, which allows them to zoom around in the air from point to point rather than having to laboriously run across large spans of terrain. Apart from providing an efficient means of navigation, this facility also enables them to obtain a bird's-eye view of the field force dynamics operative at any point in time in any place. Use of the jet pack is governed by a "life bar" whose length reduces as it is used. The life bar is automatically replenished when the player returns to ground level of her own accord or plummets to the ground if the life bar is depleted. The game also provides a snapshot facility that allows players to take a screenshot for reference in the curriculum's follow-on sense-making process. The ability to toggle between first- and third-person viewpoints, fly by means of the jet pack, and take screenshots of the game world constitute a powerful combination of means by which players can interrogate the game world and document their investigations.

Level 2 of the game, located at the site Tulen, extends the game play of Level 1 by granting players the means to deploy vertical as well as horizontal electric fields. The provision of vertical fields releases them from the constraint of 2D particle deflections as players can now deflect charged particles in the full 3D space afforded by the game. To match the greater power of game play afforded in Level 2, the game is also made more challenging: players must now direct the charged particles around an obstacle and up a slope, as indicated on the world map (Fig. 6.4).

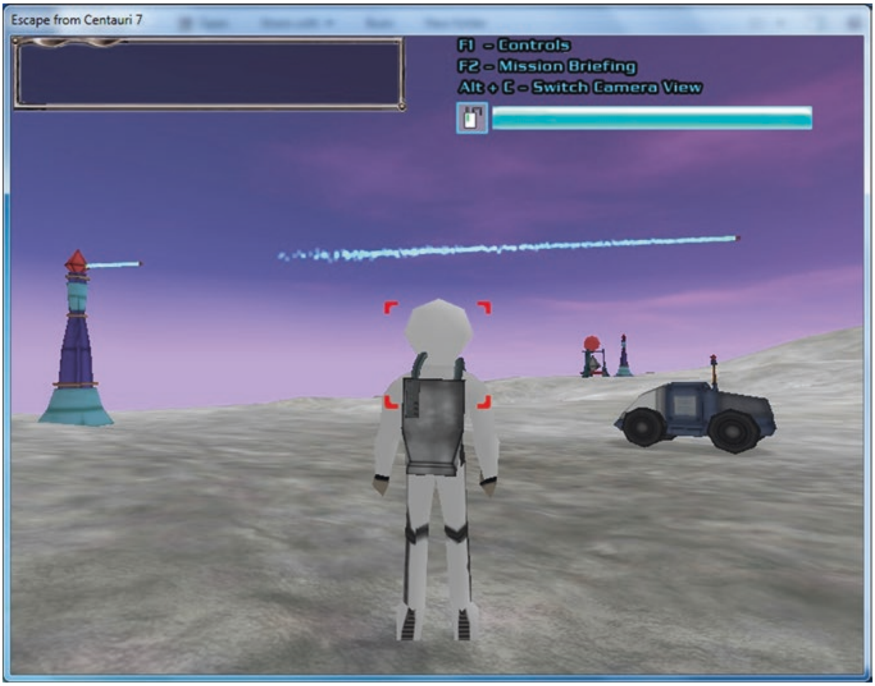


Fig. 6.10 Trajectory of a negatively charged particle that emits a blue trail

Level 3 of *Escape from Centauri 7* plays out at the site Tergis. The novelty in this level is that particles now comprise a mixture of those that are positively charged, as in the earlier game levels, and those that are negatively charged. Positively charged particles emit an orange trail as stated previously (see Fig. 6.9), but negatively charged particles emit a blue color trail (see Fig. 6.10), a visual feature of the phenomenon that students must notice when attempting to make sense of what may appear, on first encounter, to be inconsistent behaviors of charged particles. Unlike positively charged particles that deflect to the right when traversing an electric field with the field strength indicator dragged to the right, negatively charged particles deflect to the left when the field strength indicator is on the right. When playing this level, students typically fail to notice this significant difference initially. They are puzzled as to what is going on and often attribute the seeming “misbehavior” of the particle in question to programming error. When this happens, teachers usually encourage students to observe the particles a little more carefully.

Level 4 of the game occurs at Phoran, where two hills lie between the first particle emitter with its associated generator and the final target. This topography makes it extremely difficult, if not impossible, to activate the generators scattered around the terrain as a connected network with the aid of the mobile buggy alone. Consequently, a new type of transport, an airship, is introduced (see Fig. 6.11).

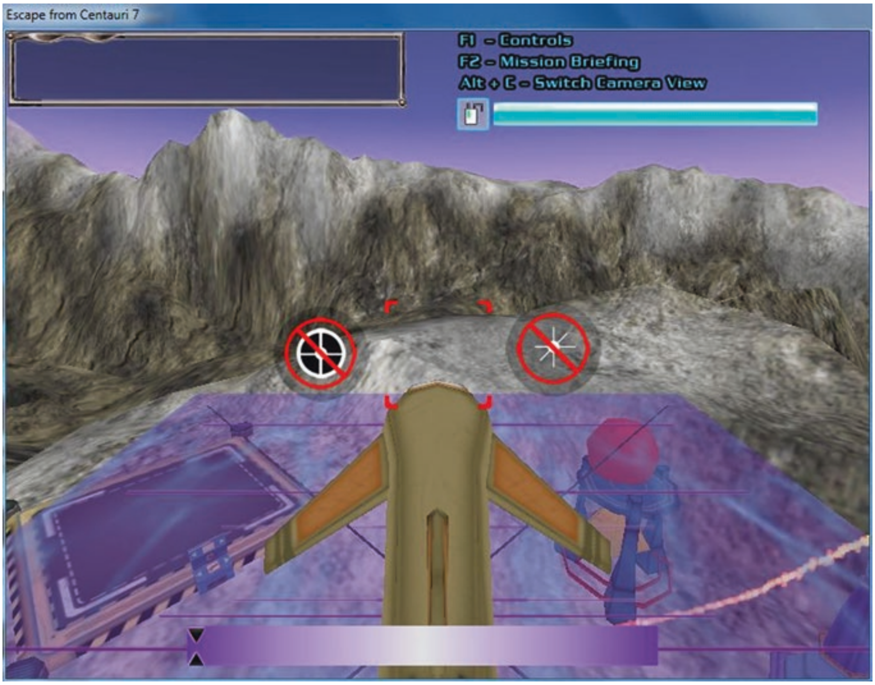


Fig. 6.11 The airship with an electric field deployed in mid-air

The airship is generated at the same vehicle generation platform as the mobile buggy. But, it is a vehicle that can take flight and thus deploy an electric field in mid-air. In terms of physics, this level does not introduce any new conceptual elements.

Things take an interesting turn in Gonem, representing Level 5 of *Escape from Centauri 7*, when players find that some terrain buggies deploy a different kind of field, which is coded in the color green. The players find that the first particle emitter fires straight into the face of a cliff whose diameter is so wide as to render the deployment of any electric field ineffective because the maximum displacement of the particle, whether to the right or left, still sends the fired particle into the cliff face (see Fig. 6.12). Given this situation, players are excited to encounter the new type of buggy, which, unknown to them initially, deploys a vertical magnetic field. Unlike electric fields that deflect particles in a parabolic path parallel to the orientation of the field, magnetic fields deflect charged particles in a circular path perpendicular to the direction of the field. Thus, Fig. 6.13 illustrates how the vertically oriented magnetic field is able to deflect the charged particles coming at it from the right such that the particles execute a U-turn and travel away from the field on the left-hand side. In this way, the challenging situation depicted in Fig. 6.12 can be overcome. Students must, however, make sense of the behavior of this new field and reconcile it with behaviors experienced with earlier fields: a

Fig. 6.12 The seemingly impossible challenge in Gonem where the particle fires into the cliff

challenging learning task. Fortunately, they have the benefit of being able to dialog with their peers, both at the player group level and at the whole class level.

In Level 6 of the game, located at Senid, players are perplexed to find that the particle emitters are damaged, with the consequence that the particles hover stationarily beside the emitters. This game level requires students to learn how electric fields initiate a force that will set the particles in motion; hence, they can be harnessed for this purpose. They must also recognize that magnetic fields do not generate such a force and hence cannot be used to initiate a particle's motion. To further augment players' power to manipulate charged particles, this game level also introduces horizontal magnetic fields.

As indicated in Sect. 6.2, students only played Levels 1–6 and Level 10 of the game in our enacted classroom curriculum. Apart from the issue of limited curriculum time, Levels 7–9 were omitted for the further reason that they addressed a further type of field—the point charge field—that is usually studied only in a more advanced curriculum. Consequently, I shall omit further consideration of these levels. Level 10, which takes place in Ducat, is a summary game level where students have the mission of successfully firing the coil gun they find there to send a message to their fellow space explorers in outer space to seek for help to be rescued from Centauri 7 (see Fig. 6.5).

Fig. 6.13 Vertical magnetic field deflecting a positively charged particle in a U-shaped path

6.4 Student Learning Outcomes

The *Escape from Centauri 7* curriculum represents an earlier piece of work compared with that of *Statecraft X* and *Legends of Alkhimia* (see Chaps. 4 and 5). In addition, it was developed with significantly less funding than the curricula related to the latter games. For these reasons, our school-based research was more experimental in nature as well as more limited. The curriculum was pilot tested with two schools initially. The teacher in one of the schools further re-enacted the curriculum in the next two years, having achieved good outcomes at inception. This section reports on student learning outcomes derived from the second year's curriculum implementation, which took place in 2007. In the third year, 2008, the curriculum was implemented solely by the teacher, who was by then confident and able to run it with little direct involvement of the research team. Notwithstanding, we still had access to students' reflection data.

The said curriculum intervention was constituted as a 12-h learning program entitled "Learning dynamics in electromagnetic fields with an interactive simulation environment." This curriculum was offered as one of several modules in the school's annual Differentiated Modules Program (DMP): a three-week segment of the school year where 15-year-old students took a break from the regular scheduled timetable to learn more advanced topics aligned to their personal interest. Thirty-six students participated in this particular intervention, DMP2. Due to the limited number of personal computers available in the computer laboratory, the cohort was divided into two subgroups of 18 students each.

DMP2 took place in September 2007. The curriculum consisted of eight 90-min computer laboratory-based sessions. Given the context of the study, no comparison with a control group was possible because there was no comparable group of students who were learning the said topic in a conventional, non-game-based way. Consequently, a pre/post test was administered. The test comprised 10 questions: (1) eight multiple-choice questions drawn from the Force Concept Inventory (FCI) developed by Hestenes et al. (1992) to assess students' grasp of Newtonian physics, kinematics, and parabolic motion, and (2) two short-answer questions designed to assess students' understanding of the concept of fields and the motion of charged particles in electric and magnetic fields. A paired *t*-test was used to determine whether there was a significant difference in students' conceptual understanding of key concepts in the subject domain before and after participating in the *Escape from Centauri 7* game-based learning curriculum. The statistical test is based on the paired results of 34 students because two students were absent from the post-test. The pretest mean was 15.77 ($SD = 4.91$) while the post-test mean was 34.46 ($SD = 4.27$). The maximum score of 40 comprises 8 marks for the FCI multiple-choice questions and 32 marks for the qualitative questions. The *t*-test was statistically significant ($t = 11.90$; $p < 0.001$).

Students were asked to complete a reflection on their experience of the curriculum upon its conclusion. Three student reflections are shared here: two from DMP2 and one from DMP3 in 2008.

Student 1 (DMP2):

> Personally I thought this DMP is a new experience. It provided me another view on science. Now we are no longer on the learning end, but creating our own rules, our own theories. This challenged my perception of physics. During the first session of this DMP, I was still trying to identify the field, explain the particle, and just trying to find the fastest way out, and I simply thought of it as another puzzle game. But after the first class discussion and reflection, I saw the point of this DMP. It was not to test our library of knowledge on science, nor was it to race each other to complete the level, but to learn the process of scientific inquiry, to formulate knowledge out of observations and experiences as a community. And in the subsequent logs, we were not just simply answering the questions, but taking down minor logic steps that led us to the final answer. It was not simple at first, but as we progressed, and learnt that using visuals such as diagrams to complement our explanations, we were able finish the thinking process. This was not a game of solving puzzles, but a game of formulating observations into generalizations. Overall, I saw the other side of science and found fun in not learning what others formulated, but formulating our own science. And the creation of the manual further ensured that we were making science.

Student 2 (DMP2):

> Though this is a physics module, I did not learn the stuff about physics only, but also the way to think, the way to draw conclusions about observed phenomenon. Adding on are the skills for exploring science. This was the most beneficial thing I acquired. Compared

> to usual physics lessons, where the teachers usually like to tell what is right and what is wrong, and then come up with a orthodox reason to explain it, where only job students need to do is to understand and memorize, this module allows students to explore through the game, observe the situation, analyze it and draw their own explanation and conclusion. One thing I realized in this module was that the teachers didn't tell much right or wrong, instead, they encouraged us to think ourselves, use our knowledge to reason. I like this very much.

Student 3 (DMP3):

> Initially, I found the whole concept and idea of the Escape from Centauri 7 module confusing and hard. I did not fully understand the game or what its objectives were, and was puzzled by the questions given on the log sheets. My initial expectations for this module were that it would be extensive and comprehensive in terms of teaching us the properties and qualities of electromagnetic fields and perhaps even more.
>
> However, I found the group discussions quite productive in learning or discussing the perplexing situations we found in the game. It was through these discussions that I understood what the questions on the log sheets meant, and how the game was meant to be played. I thought that although we might not have the total satisfaction of fully understanding how and why particles or electromagnetic fields work, the group discussions seemed to have struck me that this was how learning happened in the first place, where scientists and researchers put together ideas in order to get closer to the truth. Though at first I was uncomfortable with making mistakes or discussing as a group and I just wanted to get straight to the hard facts, I found more satisfaction learning something from each other rather than form a textbook.
>
> The greatest challenge perhaps was the green fields that appeared in Mission 5 onwards. When the purple fields were first made available, I thought that the game would be simple and easy to handle, as these fields only exert a force on the particles in a single direction. Maybe it was the underestimation of the game that made it so hard to comprehend the properties of field 2. At first we thought the field lines of field 2 behaved somewhat like sticks in the ground, and the particles had to weave in and out of them, but this did not explain the circular motion we observed, or why the particle beam could bend in two axes. We then thought the particle beam moved around points in the field, which was later confirmed in the class forum. However, it still did not satisfactorily give an explanation as to why a particle beam could bend in both the front-back and left-right axes in a coiling sort of motion.
>
> But in all, I must say that the challenges faced made this module enjoyable and satisfying. I learnt to challenge what appeared to be logic, and instead learn from scratch. It was certainly a module that was worth taking.

The students' reflections indicate that they were apt to commence the program with traditional expectations: learning a considerable amount of material deemed to be "hard facts" through being lectured on the material by the teacher. Students soon found that engaging in the process of science inquiry entailed a rather different set of activities and processes in the classroom. Sense making, discussion, and collaborative modes of learning dominated, and students began to recognize that learning science by making science through systematic inquiry and formulating evidence-based generalizations are what *bona fide* scientific knowledge construction deals with. Given their prior experience of didactic classroom learning, they found the process different and challenging, especially at the commencement of the curriculum. Making sense of the unexpected behavior of charged particles in the "green field" (i.e., the magnetic field) that could deflect particles "in two axes" simultaneously made a deep impression due to the strangeness of the behavior observed. Affectively, students reported satisfaction with the learning experience, stating how they liked it and found it enjoyable, satisfying, and worthwhile. Significantly, students learned that quality science education does not revolve around learning stuff by memorization and being told by a teacher whether they are "right" or "wrong." They learn instead that science making is community driven and, hence, a social enterprise: an important epistemological insight that is rarely achieved in the typical science classroom.

6.5 A Teacher's Reflection on the *Escape from Centauri 7* Curriculum

At the conclusion of the DMP2 curriculum intervention, we interviewed the physics teacher with whom we conducted our research. At the overall level, he expressed satisfaction with how the Escape from Centauri 7 curriculum represents an innovative way of teaching physics. He noted that his students enjoyed the curriculum. He was pleased to observe how engaged students were in the learning process and how "everything was coming from them": how students explored the immersive environment, sought evidence, made inferences, and tried to make generalizations and draw conclusions. This student-centered, active learning gave students a sense of accomplishment and ownership over their learning. The teacher further noted that although the approach of having students learn by exercising direct responsibility over their construction of knowledge was new to some of them, all students eventually appreciated it.

With respect to the activity of game play, the teacher noted that his students were very immersed in the game. Being bright students, some of them started looking for software bugs when the novelty of the game wore off. Some students, however, felt that the requirement to complete the exploration logs (see Fig. 6.2) interfered with the sense of flow in playing the game. Notwithstanding, students who took the exploration logs seriously often made full use of the virtual environment to further explore and make sense of their game play observations. Such students also began to realize early that accomplishing the mission of the game levels was a secondary curriculum objective. The teacher was further pleased to observe that students were more forthcoming with sharing their ideas when they worked on the logs as a group than when they worked on the logs individually. In addition, the teacher reflected that when the game play groups shared their presentation of findings at the whole class level, he was more concerned with emphasizing the logic and coherence of their reasoning process than the technical correctness of what they said. This emphasis suggests that the teacher placed greater value on cultivating his students' ability to think independently and coherently, as part of constructing a defensible argument, than with learning subject matter as such.

The very positive outcomes that were realized in our collaboration with the teacher described above were due, in no small part, to his being a very capable schoolteacher who grasped the intent of the curriculum readily and possessed the capacity to enact it at a high level of accomplishment. These characteristics cannot be taken for granted, and, in general, teacher professional development is a vital factor for enacting the curriculum successfully. In Chap. 7, I address challenges of facilitating greater uptake of game-based learning within the broader context of arguing the need for school reform. Chapters 4, 5, and 6, when considered together, should leave readers in little doubt that game-based learning is both desirable and achievable in practice. The challenge that we, as educators, face is to realize that potential.

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Chapter 7
Game-Based Learning and the Challenges of School Reform

The previous three chapters—Chaps. 4, 5, and 6—illustrated how authentic game-based learning can be enacted in the classroom, to good effect, in humanities as well as the sciences. In this chapter, I take up the challenges entailed in making such learning normative and customary in formal education: to make the potential actual. To achieve actuality, it will be necessary to understand why the practice of schooling resists change and how economic, social, and political forces and discourses that envelop schooling construct a nexus of interwoven customs and expectations that have the tendency to maintain the *status quo*.

7.1 The Challenges of School Reform

The school, as a formal social institution, has a history of well over a century. Over this time, the practices of schooling have consolidated and become "sedimented" to the extent that authors speak of the "intractability of schooling" (Te Riele 2009) and of schools evidencing a distinct "grammar of schooling" (Tyack and Cuban 1995). Goodlad's (2004) classic study of schools in the United States revealed nine distinct patterns of teaching and learning common across the schools studied. Johnstone and Hayes' (2008) more recent study (cited in Te Riel 2009) points to five key features that remain evident in many classrooms even today:

1. Little variety in classroom activities—listening to the teacher, answering questions, and completing worksheets or other tasks (usually individually, occasionally in groups).
2. Limited demands in terms of literacy.
3. Limited intellectual demands (mostly factual and procedural).

Y.S. Chee, *Games-To-Teach or Games-To-Learn*,
Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_7

4. The teacher is dominant in instruction and asking basic questions—students rarely engage in open discussion with each other or the teacher.
5. The teacher makes the decisions—students have no choice in what, how, or when to learn.

Unfortunately, the established traditions of schooling have come to be understood by educators, students, and the public as necessary features of a "real" school (Tyack and Cuban 1995). Consequently, the practice of schooling resists attempts to change, influence, or manipulate it in any significant way.

In their analysis of what school *is* (or has come to be, historically), Postman and Weingartner (1973, pp. 25–26) summarize school as follows:

> *[S]chool functions theoretically to prepare students for their future*. To fulfill that function, it must identify the knowledge, skills, and attitudes young people will need to survive. In doing so, *school defines intelligence, intellectual ability, and good behavior*. To determine how well or poorly the student's performance matches up with those definitions, *school evaluates behavior*. To serve its evaluating function, *school differentiates between the roles of teacher and student*. On the basis of its evaluation, *school structures time* and *structures activities* in an attempt to modify or control the student's behavior. By structuring time and activities, *school ensures supervision of the young*. In providing supervision, as in its other functions, *school is accountable to those who pay for it*. And as part of its accountability, *school aims at preparing students for the economic and social realities they will encounter as adults*. (original emphases)

Postman and Weingartner's description of school, with its functions, is intended to be as objective and neutral a statement as possible. However, we should note that, with the very first sentence, an immediate tension is created with what Dewey (1897/2004) argues strongly for in his pedagogic creed: namely, that education is a process of living and not a preparation for future living. Little surprise, then, that Postman and Weingartner (1973, p. 17) intone "'to be schooled' is not the same thing as 'to be educated'." Having established what school is, they proceed to delineate what constitutes a "good school" in relation to the functions stated above. Some examples are provided below.

- With respect to the function of activity structuring: A school is good when it recognizes that no matter how logical its activity structuring may be, the process is next to worthless if students are alienated from their activities.
- With respect to defining intelligence and worthwhile knowledge: A school is good when it moves away from valuing knowledge "for knowledge's sake" and moves toward valuing the use of knowledge in daily life. A good school comes close to saying if you do not *act* as if you know something, then you do not know it.
- With respect to evaluation: A school is good when it moves away from factory-like processing procedures and toward more humanistic, individualized judgments.
- With respect to accountability to the future: A school is good when its concept of knowledge, attitudes, and skills is oriented toward the *future*. A school is bad when it has no viable strategy or plan to deal with vast cultural change.

The examples cited above should furnish readers with a concrete sense of the kinds of *qualitative* changes regarded as desirable (at least in certain quarters) and to be sought through school reform. It also indicates why the reform process is always fraught with deep challenges that revolve around differences in values and envisionments of preferred futures held by different stakeholders in the education sector. In his critical analysis of high-stakes educational testing, Ydesen (2014) identifies three separate levels of stakeholder involvement: first, the macro-level, which encompasses governing authorities, education leaders, and society-at-large; second, the mesolevel, which subsumes teachers and parents; and third, the microlevel, which concerns the students themselves. It should be apparent that the vested interests of agents at each level can be, and often are, vastly divergent. Macro-level stakeholders typically pay great attention to gatekeeping and education access issues; they are often also consumed by concerns over education standards, international benchmarking, and enhancing the good standing of a country's education system in world rankings. At the mesolevel, teachers are usually taken up, by force of necessity, with delivering on the governing authority's performativity indices and benchmarking requirements (Burnard and White 2008), with parents often competing to ensure that their child not only does not get "left behind", but actually gets ahead, academically as well as in the accumulation of social and cultural capital. And what of the students at the microlevel? Can they demand an education experience befitting Postman and Weingartner's "good school"? Being the least empowered, they are typically left to accept the quality of schooling they are offered and to conform and comply with the demands placed upon them. It is always pertinent to ask then, as Ydesen advises, *Cui bono?* That is, who benefits?

There is a sizeable literature on school reform and how to make it work (see, for example, Fullan 2007; Hargreaves 2009). Childress, Elmore, Grossman, and Johnson (2009) detail the Public Education Leadership Project (PELP) framework, which grew out of a project at Harvard University. The project arose from collaboration between education and business school faculty, in partnership with a network of urban school districts. Perhaps unsurprisingly, the project outcome was the identification of five common *managerial* challenges that urban districts faced as they attempted to implement a strategy for school improvement:

1. Implementing the strategy effectively across schools with different characteristics;
2. Redesigning the organization so that it supports the strategy;
3. Developing and managing human capital to carry out the strategy;
4. Allocating resources in alignment with the strategy; and
5. Using performance data for decision-making, organizational learning, and accountability.

While this finding may be valuable in certain ways, it should also be evident that the authors speak from the vantage point of the macro-level: that of governing authorities and education administrators. This information would be useful in contexts such as a nationwide "back to basics" school reform movement. However, voices from the meso- and microlevels are not heard. In similar vein, although

Fullan (2007) provides a model of the change process that entails initiation, implementation, and institutionalization, with hoped for outcomes that impact student learning and the development of organization capacity, this perspective is again a macro-level viewpoint. Fullan recognizes that change is not a singular entity but a multidimensional one, which, from his perspective, entails the following: (1) the possible use of new or revised materials including curriculum materials or technologies, (2) the possible use of new teaching approaches, and (3) the possible alteration of participant beliefs. Notwithstanding, my assessment of his "take" on the subject of reform is that the kind of deep onto epistemological, praxiological, and axiological change outlined in Sect. 2.2 of this book surpasses his more circumscribed perspective of the *raison d'être* of education as articulated by well-known education philosophers such as Dewey (1916/1980, 1990, 1995), James (1899/2007), and Whitehead (1929). As a result, Fullan (2010, p. 21) can only propose overgeneralized reductivisms such as the following on the "elements of successful reform":

1. A small number of ambitious goals;
2. A guiding coalition at the top;
3. High standards and expectations;
4. Collective capacity building with a focus on instruction;
5. Individual capacity building linked to instruction;
6. Mobilizing the data as a strategy for improvement;
7. Intervention in a non-punitive manner;
8. Being vigilant about "distractors"; and
9. Being transparent, relentless, and increasingly challenging.

I have no quarrel with the usefulness of the maxims listed above if the objective is to deal with schools that are failing or if the goal is to achieve more effective *schooling*. However, following my arguments in this book (especially in Chaps. 2 and 3) and also those made in Chee (2015), the key challenge that needs to be addressed today revolves around the tension between schooling and educating children, rather than one of enhancing their schooling. For the agenda of educating to be served, it will be necessary to reframe the basic tenets of what constitutes good education befitting current times and to ensure that students' need for educational growth is prioritized and the imperative of social justice is adequately served.

Unfortunately, the history of attempts to reform schooling is marked by a litany of successive failures. Cuban (2013), for instance, argues that classroom instruction in the United States has been largely impervious to structural reforms aimed at moving teaching practices from teacher-centered to student-centered and moving students from absorbing subject matter to critical thinking and problem solving. Consequently, "there has been much change in schools and classrooms but so little reform of the fundamental structures … that sustain continuity in [traditional] teaching practices" (p. 171). Concerning the introduction of educational technologies into classrooms, Selwyn (in press) asserts that "the past 100 years show that education has largely been *un*-transformed and *un*-disrupted by successive waves of technology innovation. Empirical research has remained resolutely equivocal about the 'learning' that can actually be said to result from the use of digital technologies" (p. 3, original emphases). Both Cuban and Selwyn decry the widespread but poorly informed talk of policy makers, business leaders, journalists, and philanthropists related to technology and school reform. They speak of this discourse as "soaring rhetoric" and "trafficking in words" (Cuban 2013, p. 13) and as sheer "bullshit" (in the technical sense—introduced by Frankfurt (2005)—that such language is excessive, phony, and repeated mindlessly without regard for how things really are) (Selwyn, in press, p. 3). Giroux (2014) argues that such discourse, which permeates the public arena, reflects dominant neoliberal interests that propagate a preference for superficial and vacuous talk divorced from matters of ethics, social responsibility, and social cost.

The limited applicability of a top-down, macro-level-induced approach to school reform becomes evident when due consideration is given to the human side of school change. Considering the mesolevel of school systems, Evans (2001) analyzes why teachers often resist reform. He suggests that it is crucial to be sensitive to teachers as human actors in the school system and to respect their ideals, needs, and fears when reform is instituted. Evans suggests that the sedimented culture of schooling practices can be like a prison that constrains teachers' perspectives and limits their problem-solving approaches when dealing with change. He articulates how change can threaten teachers in four different ways. First, teachers often experience change as a kind of loss that brings about a sense of bereavement. Because the meaningfulness of life depends on predictability, disruption is experienced as a discrediting of the familiar assumptions that grounded the predictability associated with a certain of way of understanding the world and of doing things. Second, change also threatens people's sense of competence, often frustrating their wish to feel effective and valuable. Third, performance in an organization depends on the clarity and coherence of its design, roles, rules, and policies, from which emanate the felt security of predictability and teachers' sense of professional meaningfulness. Disruption thus almost always brings about confusion and unpredictability. Fourth, although innovation is always promoted as being good for everyone, the reality is that change almost always generates friction, between individuals as well as between groups, because it invariably produces winners and losers, at least initially. For these reasons, sensitive, human-centered change management processes are vital in order that they lead teachers and other school agents from loss to recommitment, from old competence to new competence, from confusion to recoherence, and from conflict to new-found consensus, if that is possible. Given that all attempts at organizational change have unintended social consequences and hence drift in unexpected ways, it is critical that working solutions be designed and experimented with, first locally, before attempting to spread them through human dialog and further experimentation (Virkkunen and Newnham 2013). Seen in this light, social change imposed by authoritarian bureaucracies is a recipe that invites disaster.

Overall, Cuban (2013) construes change in schools as a process characterized by "dynamic conservatism" that involves both continuity and change to maintain a tenuous balance between the old and new. For this reason, teachers in schools frequently respond to major reforms by adopting only those parts of the prescribed changes that will allow them to ensure the system's continued stability. Little surprise, then, that schools appear to be continually "circling the mountain"—indulging in constantly shifting scenery while not traveling to anyplace different. This maneuver creates the appearance of continual improvement while remaining fundamentally unchanged.

Given the general lack of progress in school reform, critics such as Illich (2000) have essentially given up hope for change and have called for the deschooling of society. In more current times, Gee (2013) has also intimated deep skepticism for any progress on the issue, having dubbed the present era of schooling the "anti-education era" because "[w]e focus on skill and drill, tests and accountability, and higher education as a marker of status (elite colleges) or mere job training (lesser colleges). We have forgotten education as a force for equality in the sense of making everyone count and enabling everyone to fully participate in our society" (p. xiv). Furthermore, "we need to be educated, but not indoctrinated. Our formal institutions of education have, by and large, given up the task of deep education for the short-term goals of test passing and tuition payments" (p. 7). This statement is a sad indictment of the state of education in the United States, as well as, one might argue, internationally, as a result of actors such as the OECD that have overwhelmed the public discourse on education in favor of a narrow and overriding economic imperative, framed in the context of globalization, privatization, and deregulation (Rizvi and Lingard 2010).

7.2 Local-Level Challenges

Based on his extensive interactions with policy makers, researchers, practitioners, journalists, and parents, Cuban (2013) suggests that three broad reasons are most often cited in explaining why schooling practices resist change. First, teaching traditions are supported by popular social beliefs, reinforced by successive generations of new teachers, and fortified by the age-graded school structure. Second, teachers are resistant to reform. Third, fundamental errors in the thinking and actions of policy makers in designing and converting policies into classroom practice keep teaching practice stable.

In this section, I push back against the notion that teachers ought to shoulder a major portion of the blame for the uncanny ability of school systems to maintain the *status quo*. While teachers are clearly important system players, to hold them solely accountable would amount to committing a fundamental attribution error. Cuban points out that teachers have no control over the knowledge, skills, attitudes, and habits that students bring from home to school. Neither do they make policy decisions that establish the conditions under which they teach daily. It is state and district policy makers who set goals, allocate resources, and establish the structures of schooling. They determine standards and assessments; they also determine class size and where new technologies are deployed. They further establish pay-for-performance schemes and organize professional learning communities. Indeed, teachers are often reduced to subjects with limited agency, who are bound by institutional culture. Consequently, they often find themselves caught between a rock and a hard place.

In this section, therefore, I shall address specific dilemmas and challenges that teachers faced in relation to my own research on game-based learning. I do this in the context of the Statecraft X curriculum. The findings I report arise from a follow-on project directed specifically to meet the professional development needs of our collaborating teachers directed at allowing them to develop the capacity to enact the said curriculum. Detailed results can be found in Chee, Mehrotra, and Ong (2014) and Chee, Mehrotra, and Ong (in press-a).

Recall that the Statecraft X curriculum is predicated on a performance pedagogy entailing both game play and classroom dialog (see Chap. 4). For the said project, we collaborated with nine social studies teachers from five government secondary schools. Five teachers enacted the curriculum twice while the remaining four teachers enacted it once. Despite the novelty of the game and the mobile technology used, we found that teachers did not find either of these factors to be a major challenge. In all likelihood, this was the case because the game was played outside of class time; consequently, teachers were, to a large extent, spared from dealing with the complexities of game play. They were also spared from having to provide technology support, as members of the research team fulfilled this function.

What teachers found demanding was enacting the dialogic pedagogy required by the Statecraft X curriculum and wrestling with the tensions introduced between dialogism and the culture of didactic instruction that permeates schooling. Not being trained in facilitating dialogic learning, teachers often found themselves in dilemmatic situations. From a theoretical perspective, dilemmas are part and parcel of professional work. They often arise from conflicts between professional identity and having to deal with gaps between personal beliefs and the "hard" reality of schools and classrooms (Ben-Peretz and Kremer-Hayon 1990). Berlak and Berlak (1982) suggest that teacher dilemmas are of three types: those that related to control, to curriculum, and to social norms. Dilemmas entail messy situations that grant no simple "right" answer. They typically entail moral choices and are frequently dealt with by satisficing or they are left unaddressed given the absence of a ready solution (Cuban 1992).

Based on our research, we found four categories of teacher dilemmas. The first category of dilemmas concerns students' resistance to and/or discomfort with a new mode of teaching and learning, that is, with dialogism. For example, one teacher shared the reaction of a student who was an overseas "scholar" in her class. When informed that "we will not go back to the textbook, we will just move on to the next [topic in] the syllabus," the student was "very, very concerned" because "y'know results come first more than game." As an authentic digital game, *Statecraft X*™ does not "teach" the four doctrinal principles of governance in the social studies textbook as propositional statements. Instead, these otherwise inert ideas are brought to life through students' game play. Through inquiry, students are invited to construct their own principles of governance and compare them with the prescribed ones. Given the scholar student's reaction, the teacher was placed in a dilemmatic situation such that she felt it necessary to assure her class, at the close of the game-based learning curriculum, that they had engaged in productive learning: "we need to make it explicit to them," so "they don't think they are being shortchanged." Clearly, some students would have been more assured compared to others, leaving the teacher in a somewhat awkward predicament.

The second type of dilemma concerns teachers' perception of system requirements and normative expectations. Teachers often feel highly constrained to do only the education system's bidding. Thus, a teacher reported:

> … sometimes stakeholders in school will have different ideas – they want to finish the objectives and syllabus, they want to finish this particular part, they have this pen and paper exercise that you must do. And to be honest um, some departments are actually very rigid about such stuff.

The third type of dilemma revolves around the pressure that teachers feel they are under to ensure that students score high marks on standard tests. Toward the end of one particular curriculum intervention, when asked about how she was feeling about her classroom teaching, a teacher confided:

> Worried, because in the end of the day, I'm a teacher (and) I need to produce the results. As in not like produce results, but I need to have results. So I'm worried in a sense that I don't know how they will fare in the next test.

The teacher's sense of worry and the feeling of unease arising from this are palpable. Given that she had only enacted the game-based curriculum once, her new professional skill set was still a work-in-progress. However, she felt as if "judgment day"—"the next test"—was imminent, and she was desperate to actually *have* students' good test results in hand. In expressing this, we can detect a sense of fear: the fear of being judged a non-performing teacher by her superiors.

The fourth type of dilemma has to do with weak alignment between mandated and innovation-based forms of assessment. As with all conventional schooling, it is well known that "content is king." One teacher informed us:

> I would say that this package will only cover the concept of governance in the broad sense, but not so much the textbook and expected answer sense. Because in the textbook there are expected content that they are supposed to know like ERP, COE, and the other, other systems that ensure that Singapore has a smooth traffic for so-called, but of course, this is not covered in Statecraft, so these are still relevant questions that will be coming out in the exams and we still have to teach them and it comes under governance.

The formal social studies curriculum mandates that students know content related to implemented government policy, including electronic road pricing (ERP) and certificates of entitlement (COE) used to control road usage and the ballooning car population. While it is entirely reasonable to want students to know about all this, a difficulty arises when this information is assessed as inert content framed as predetermined "expected answers." Given the Statecraft X curriculum's orientation toward inquiry learning, the assessment we used took the form of a student essay that focused on governance in relation to citizenship, not on factual content. As a consequence, some teachers sensed being caught in a dilemma because they felt compelled to teach the explicit content as well after completion of the game-based curriculum so that they could feel "safe" in having discharged what they see as their professional responsibility in carrying out explicit teaching of the said content. Needless to say, teaching the content (as content) in addition to executing the game-based curriculum would amount to doing double work. Such a course of actions would run entirely counter to the intent of the game-based curriculum: namely, that it should constitute an alternative pedagogical learning model rather than an additional one. Little wonder, then, that some teachers would be found resisting the new curriculum.

Apart from dilemmas brought on by tensions between dialogic classroom practice and habits of didactic instruction that permeate the culture of schooling, it should be noted that enacting dialogic pedagogy before a classroom of students is itself constitutive of performance (Bell 2008; Carlson 2004). Teachers, in effect, needed to learn to perform differently in front of their students. This need to enact a different kind of teaching role gave rise to two main challenges that teachers had to grapple with as they sought to teach differently.

The first main challenge stems directly from teachers' efforts to reconstruct teaching practice. This challenge manifested itself in four distinct ways. First, teachers were challenged in having to learn to think and act in real time "on one's feet," as expressed by a particular teacher. Another teacher shared:

> I totally forgot about the refugee arrival! … And that was actually what I had planned, as in like in my head, thinking of the refugee arrival and to link it to migration…. That was what I had in mind before I step into the lesson…. But during the lesson, as it was going on, yeah, then I sort of got lost in the things that they were saying.

Being accustomed to working from a predetermined lesson plan with all the steps and needed actions laid out well in advance, the teacher now found that she had to respond in real time to the ideas her students were contributing from their game play experience since the last time the class met. Given that the in-game event of the refugee arrival had been triggered, there was a perfect opportunity to link this event to a conversation revolving around migration and immigration. However, in the hurly-burly of real time dialog, the teacher "got lost" in what the students were saying such that she inadvertently let slip her intention to relate students' game experience to the important issue of cross-border migration and issues to consider when establishing immigration policy.

Second, teachers were challenged in trying to overcome old teaching habits. A teacher spoke of the difficulty "of really being a facilitator rather than the traditional 'imparting-of-knowledge'" kind of teacher she was accustomed to being. The "loss" of PowerPoint slides as a teaching scaffold also surfaced as an issue. For example, another teacher commented:

> Yeah, we are always prepared with PowerPoint slides and we are … And even if there is a discussion we know where to always go back to. And I think being used to that. That is a hindrance that I need to get rid of.

This teacher used to value her slides as a scaffold that would direct her back on track with regard to her predetermined lesson plan. However, given her experience thus far with dialogic pedagogy and the value placed upon students' voice, she now began to view the slides as a "hindrance" to be gotten rid of.

Third, teachers often struggled with the challenge of maintaining a natural conversation flow becoming of a dialogic classroom. One teacher shared how the low point of a class session was that "I couldn't pick up y'know enough on these things and I felt like the session didn't … I felt like there wasn't a flow. I just felt like it was here and there." Another teacher disclosed:

> … it's also pressurizing because things may not go well. … Things may not flow well, you know and then there are moments where some … I guess in the beginning with [refers to a particular class], sometimes when I felt like "okay, oh no we are stuck. What should we do now?"

Both teachers were sensitive to classroom dialog not being smooth even while they enacted their teaching, and they felt pressured, or stressed, because of this. The sense of crisis arising from being stuck—"what should we do *now*?"—is unmistakable.

Fourth, teachers felt challenged when they dropped points and missed opportunities to interrogate ideas. For example, one teacher shared:

> Lowest point, the first one would be the dropping of points. Because, yeah, I think as a teacher you always look out for teachable moments. It could be the teaching of values, I mean, um, so I thought you know when the students said "I don't really care about the people" you know, I thought … yeap that was one – why do you not care, that is so obvious that people would be one of the most crucial, because without people then you will not have the town, you know.

Unfortunately, she failed to capitalize on what her students, in the role of town governors in the game, had said concerning not caring about the citizens. Consequently, a "teachable moment" was lost and a "point was dropped" much to her distress.

The second main challenge that teachers grappled with relates to classroom culture and the need to redefine relations with students. It is difficult to develop a dialogic classroom culture if teachers are accustomed to an authority position with respect to subject matter as well as role power. One teacher, in particular, was able to transcend this challenge. She spoke of preferring to be "closer to students" and of being "a bit more pally" with them. In one of the last few interviews with her, she reflected on her learning journey with the Statecraft X curriculum in the following terms:

> … initially as I, you know, started as a fresh beginning teacher, it's really like okay, a teacher um doing the teaching. And um … it's more of top down because I'm the one having all the subject knowledge content. I have all the information and I know that … I clearly know that my students do not have access to all these. So I feel that I have an advantage over my students.… So I feel I have the upper hand. But you know as I do this um Statecraft X project, I find that it is … Okay, I [laughingly with emphasis:] descend to be of the same level as the student whereby I find myself learning a lot from the students and they are definitely in the capacity to teach me. And in fact, some of them they might

> even know more than me. And from a teacher, I become a facilitator. And at the same time, I am also a learner. So I'm of the same level as the students …

This teacher was unique in that she manifested the ability to deal with the culturally enforced power relation between teachers and students that is commonplace in Singapore schools. She showed genuine readiness to "descend" and be "of the same level as the students," surrendering her "advantage" and "upper hand" in order to be effective as a teacher. Furthermore, she showed herself willing to learn from her students who, she felt, might "know more than me." In the process, she learned to be a *bona fide* facilitator of student learning.

The foregoing account of dilemmas and challenges teachers experienced in their endeavor to enact authentic game-based learning in the classroom should make it apparent that the process of reconstructing practice is non-trivial. I argue that an adequate account of professional change is not possible without taking into account identity as a cornerstone of "shifting" teaching practice. As the earlier discussion has intimated, teachers' enactment of Statecraft X teaching practice is constitutive of performance. This performance evidences their identity as (professional) learners, just as it applies to students who learn with any game-based curriculum (see Chap. 3). Consequently, teachers' learning likewise entails their interwoven knowing–doing–being–valuing, representing the epistemological, praxiological, ontological, and axiological dimensions of learner identity (see Fig. 7.1).

In Chee, Mehrotra, and Ong (in press-b), I illustrate, through interview excerpts with teachers, how these facets of learner identity are implicated in how teachers learn to be proficient Statecraft X teachers. Figure 7.2 depicts the process by which teachers appropriate the innovation of game-based learning, that is, the innovation's uptake.

The figure represents my own appropriation of Coburn's (2003) proposal that four interrelated dimensions of change are important for educational reform to

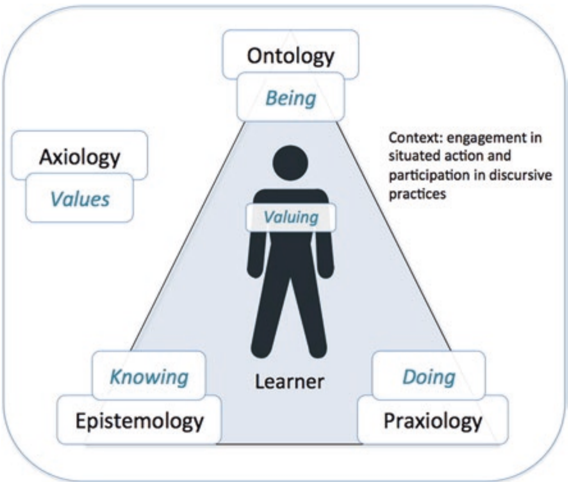

Fig. 7.1 Framework for researching human learning as performed identity

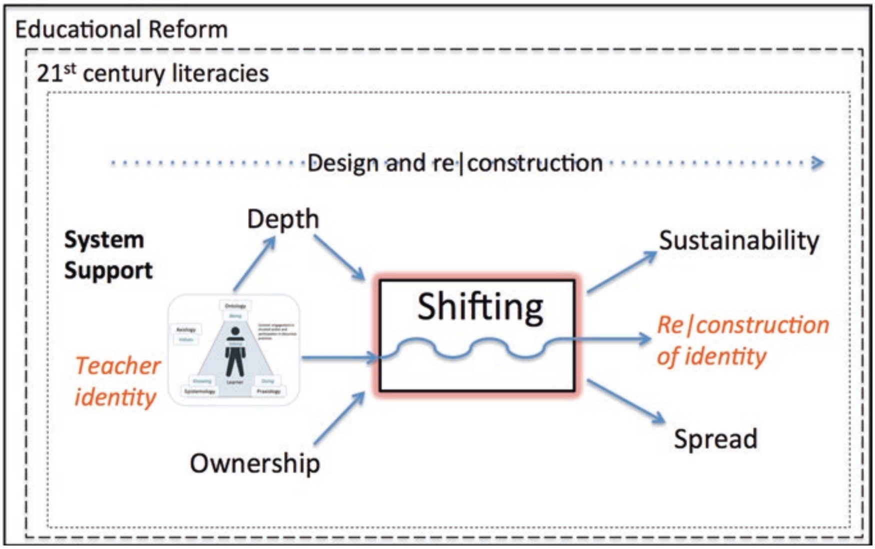

Fig. 7.2 Final “shifting” model of innovation uptake

achieve traction. These dimensions are depth, sustainability, spread, and shift in reform ownership. From a teacher development perspective, I repurposed several of these constructs to serve the research at hand. In particular, I separated “shift” from “ownership” thereby allowing a focus on “shift” in teaching practice, framed in terms of skillful enactment of dialogic pedagogy in the context of game-based learning. The term “depth” bears the same meaning as proposed by Coburn: namely, that scaling efforts entail deep changes at the level of pedagogical principles such that these changes, in turn, alter teachers’ beliefs and the norms of social interaction in the classroom. In the original model, I envisaged that a deep understanding of new pedagogical principles together with teacher ownership over the new pedagogy would strongly influence the extent to which a teacher’s shift in teaching practice would be strongly rooted and, thus, whether and to what extent the desired outcomes related to the innovation would be achieved. That is, “depth” coupled with “ownership” would facilitate a “shift” in teaching practice, evidenced by “sustainability” of the new practice and its “spread” to other subjects and classes. System support, in the form of school leaders’ support as well as adequate technology support, where appropriate, was considered an essential environmental factor. I added a fifth dimension, “design and reconstruction,” to encompass teachers’ iterative reconstruction of an innovation as they adapt it to their own needs and setting over time, as suggested by Clark and Dede (2009).

However, the research findings related to teachers’ dilemmas and challenges strongly indicated the need to factor “teacher identity” into the original model of innovation uptake. Consequently, in the final model shown in Fig. 7.2, “teacher identity” is shown to directly impact “depth” as well as the change *process*, depicted as "shifting." The wavy line used to depict the shifting process indicates that the process is fraught with contingency; hence, the outcome cannot be reliably predicted in advance. Engaging in shifting "forces" teachers to deeply interrogate their knowing–doing–being–valuing through reflection and reflexivity (Chee and Mehrotra 2012). For teachers who succeed in shifting their practice, the journey is transformational as their identity is reconstructed. To illustrate, one teacher shared the following narrative that centers on personal transformation and professional growth:

> You know how a pearl is formed—you have a grain of sand—it's like you know you have an oyster and then there is this grain of sand comes in and you are really irritated by it, really annoyed that there is this grain of sand but of course you kind of allowed that a grain of sand to come in.… some excretion and that's how the pearl is formed when it hardens. And then you become this pearl, that's something precious, and I think my journey is something like that.

Quite evidently, the teacher's journey was an arduous one, but the end result was, as with the formation of a pearl, the fulfillment of something precious and deeply meaningful. By contrast, teachers who were less successful in appropriating the new pedagogy offered less compelling narratives that placed the focus on their students rather than on themselves. For example, a teacher likened her experience to leading her students through a dark cave, lighting the path ahead for them. The differences in narrative are illuminating. In order to maximize the likelihood of successfully shifting practice, teachers need to be provided with professional development support to help them attain an enhanced level of teaching practice.

I have now addressed the teachers' perspective with respect to innovation, which potentially initiates deep change in teaching practice. What might be said concerning the students' perspective? Stokes and Wyn (2009) argue that, for young people, engaging in identity work has become increasingly important as they transition through school to work and adult life. Youth today increasingly realize that, amidst the turmoil brought on by constant change and ongoing economic uncertainty, they must develop capacities for reflexivity and reflectiveness and take heed not only to developing occupational skills but also to sound attitudes, ways of relating to others, and ways of presenting themselves. In a nutshell, as expressed by Beck and Beck-Gernsheim (2002), "needing to *become* what one *is* the hallmark of modern living" (pg. xv, original emphasis). Success in modern life is thus related to the capacity to continuously construct oneself through executing thoughtful choices and to demonstrate that one can take responsibility, be resourceful, and is enterprising (Rose 1999). Sadly, in an age where narrow, economistic educational policies that focus almost exclusively on matching skills to national economic needs dominate, young people are afforded little opportunity to engage in identity development. Schooling routinely ignores complex identity transactions that occur in the classroom (Wortham 2006), while authority-centered power continues to keep students on a tight rein. Fortunately, the Statecraft X curriculum carves out a space within which students can begin to engage in identity work in relation to their role as citizens. It is worth noting that

Dewey (1916/1980, pp. 115–117) reflected on the control experienced by both teachers and students in the school setting in the following terms:

> The vice of externally imposed ends has deep roots. Teachers receive them from superior authorities; these authorities accept them from what is current in the community. The teachers impose them upon children. As a first consequence, the intelligence of the teacher is not free; it is confined to receiving the aims laid down from above. Too rarely is the individual teacher so free from the dictation of authoritative supervisor, textbook on methods, prescribed course of study, etc. that he can let his mind come to close quarters with the pupil's mind and the subject matter.… In education, the currency of these externally imposed aims is responsible for the emphasis put upon the notion of preparation for a remote future and for rendering the work of both teacher and pupil mechanical and slavish.

7.3 Global-Level Challenges

The local-level challenges articulated in the previous section cannot be adequately understood when considered in isolation because they are enmeshed and entangled in broader global contexts that encompass social, cultural, economic, and political influences. With reference to the United States, Cuban points out that despite the "tinkering toward Utopia" reform efforts of the 1990s (Tyack and Cuban 1995), classroom practice today remains best characterized as "change without reform" (Cuban 2013). He argues that "[w]hat creates hurdles for teachers and administrators is when policy makers intent on improving schools err in viewing schools as complicated rather than complex systems" (Cuban 2013, p. 170). Failing to understand the phenomenon of "dynamic conservatism," they bring to bear principles drawn from management, business process reengineering, and corporate restructuring in their attempts to administer school improvement. With the backing of civic leaders, business entrepreneurs, and (unenlightened) philanthropists, policy leaders have sought to refashion schools so that students can compete internationally with those of other countries in order to gain a competitive edge in the global knowledge economy. Much of this "race to the top," whether in American schools or not, has ridden roughshod over civic concerns directed toward improving community engagement, achieving social justice, enhancing holistic education for children and youth, and educating for democracy.

Thomson, Lingard, and Wrigley (2012) argue the importance of reform efforts taking place in a top-down, bottom-up, and inside-out fashion. Such a process entails negotiating a tangle of taken-for-granted ideas, practices, identities, histories, and deeply held "truths" of key stakeholders. Nations, they further argue, need to recognize widespread differences between their schoolchildren and seek to (re)distribute public wealth and resources fairly. For this to occur, a vibrant civic society must demand that schools produce generations of educated local-global citizens. This forward-oriented vision stands in stark contrast to the model of schooling widely promulgated by neoliberal discourse.

This latter model is directed toward achieving greater efficiency of designated outputs through top-down, centralized change that requires comparability of student and school performances that are measured through national and international benchmarking. However, tests that focus on limited aspects of basic literacy and numeracy have led to a narrowing of curiculum. Where testing is high stakes, "cheating" occurs at multiple levels to "assist" with meeting required targets, for example, by conducting educational triage to remove students who might fall below a desired standard, intensive teaching to the test, and substituting easier qualifications and criteria for students to "make the grade." Such measures arise from fear of failure, and they result in schools practicing the "pedagogies of under-attainment" (Thomson et al. 2012), with deleterious effects.

Amidst the increasing globalization of education and its associated education policy discourses, Stronach (2010) argues that the collapse of meta-narratives arising from the Enlightenment have been followed by hyper-narratives that valorize education for economic purposes: "an education that fits the needs of a global capitalism, and the 'need' for international competitiveness" (p. 1). He notes that TIMMS, the Trends in International Mathematics and Science Study, international comparative benchmarking exercise is now a global brand, and implicitly a permanent feature of international assessment and comparison. It has become "a kind of Olympic games" (p. 1). The Olympic games, in its modern form, had a primarily educational goal of "delivering man from the constituting vision of *homo economicus*" (Stronach 2010, p. 24). The hope of the games' founders was that effective education could be in the service of a productive economy. However, it is common knowledge that the educational objective today plays second fiddle to the economic motivations of hosting the games. The global discourse has also fostered a "mythic economic instrumentalism," which suggests, through innuendo or lazy reasoning, that a nation's high ranking in such international comparisons has causal efficacy and portends future economic success. As any reader trained in research methods would know, such claims are only correlational at best. They constitute human imputations, not scientific observations.

Educational policies cannot be easily separated from other policy domains, such as those relating to economic and cultural matters (Rizvi and Lingard 2010). All such policies inherently express the value preferences of national leaders, the machinery of government, and, presumably, of the larger community as well. While there are clearly discernible education globalization narratives and policy pressures that leaders must confront, Rizvi and Lingard argue it would be erroneous to view their effects as a generalized phenomenon because their manifestations are contingent on varying cultures, histories, and politics within different nations. Increasingly, transnational organizations such as the EU, OECD, and UNESCO exert important influences in forging educational policy at the level of national systems, as politicians bear the yoke of accountability to international standards and benchmarks. The pervasive outcome is that neoliberal precepts have become not only influential, but also dominant.

Examining how educational systems have been affected by globalization and technological change, Monahan (2005) argues that globalization manifests itself in neoliberal projects, pedagogical alignment with industry, and technological contracts and commitments. School districts restructure themselves as corporations, accountability regimes proliferate, and pedagogy shifts to accommodate industry's needs for a compliant labor force that extols entrepreneurial training, flexible multitasking, mundane skills acquisition, and apolitical acceptance of the *status quo*. Under the influence of such a regime, technology symbolizes global connectedness and student empowerment. Schools invest heavily in computers, telecommunication networks, and media equipment rooted upon belief in the corrective powers of personalized technology, an unassailable faith in technological progress, and on political expediency. As technology hardwires into the structure of public education, it concomitantly hardwires a set of "reshuffled" power relations that cannot be readily eliminated without threatening the viability of school itself. As a result, avenues for political intervention by local actors become extremely restricted. Local sites can only mediate the new forces at work. Reaction and/or adaptation are the only sanctioned responses. Asymmetrical power relations develop, yielding "fragmented decentralization," a form of organization evidenced by increased centralization and decision-making authority working in parallel with decentralization of social control and punishment for failure. In this manner, the center is able to exert control while dissociating from potential adverse effects that may occur in the periphery.

As Meyer (1977) points out, "educational systems are, in fact, theories of socialization institutionalized as rules at the collective level" (p. 65). Focusing on schools or classrooms as autonomous systems obscures how political, cultural, and economic forces shape school practices and ignores many critical strands of activity that connect schools to life outside of schools (Nespor 1997).

Youdell (2011, p. 7) argues that "[s]chooling and politics are inseparable," while Selwyn (2011, p. 121) likewise observes that "[a]ny debate over the future of schooling in the digital age … is highly political and ideological in nature." Drawing upon three case studies from the Danish history of education, Ydesen (2014) concludes that, examined from a critical perspective, high-stakes testing is extremely well designed as a bulwark against opposing or alternative outlooks and opinions because (1) testing is a complex tool that requires specialized knowledge to administer effectively and (2) testing's ability to generate comparable results is commonly held to be scientifically objective, fair, and beyond reproach. The critically informed, however, recognize that high-stakes test batteries also unavoidably subsume constructed notions of normality and deviance based on test constructors' ideologies and values. In this regard, Ydesen identifies three democratic models with distinct value systems: elite democracies, participatory democracies, and deliberative democracies. In elite democracies, citizens control decision-makers by choosing among competing elites. Power is concentrated at the macro-level, and high-stakes testing generates outcomes of inequality that serve as a gatekeeper to opportunities in life. Participatory democracies are associated with the mesolevel of school life where the roles and voices of teachers, parents, and community carry the highest value as democratic agents of the school system. Deliberative democracies prize the importance of being able to engage in discussion among free and equal citizens. This level corresponds to the microlevel, which holds pupil welfare the most important. Consequently, pupil individuality and possibilities of democratic teaching and learning are most highly valued.

It should be evident, then, that school systems are thoroughly political. Global challenges to school reform, as well as the local ones illustrated in Sect. 7.2, suggest that there will likely be limited demand for authentic game-based learning given the current dominance of reductive assessments, high-stakes testing, and international benchmarking exercises carried out by non-educationists. Notwithstanding, as educators, we ought to retain robust hope for a better future (McInerney 2007), a thread that I shall take up and explain in the next chapter.

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Chapter 8
Conclusion: Future Prospects and Educational Opportunities

In this final chapter, I adopt a prospective view of the near-term future to address issues pertinent to advancing the field of authentic game-based learning. I then take a longer-term perspective and put forward a particular vision and hope for how the future, viewed as a field with infinite possibility, might unfold in a positive way.

8.1 Future Prospects

In closing her critical perusal of the digital games and learning landscape, Whitton (2014) reiterates that games have the potential to be powerful problem-based, authentic, and collaborative learning environments. However, she notes that there are many political, social, economic, and cultural hurdles that must be overcome if her vision of game-based learning is to be realized. She states: "In reality, I believe that changes in pedagogy and practice will happen in small steps rather than giant leaps" (p. 189). She sees these changes as entailing (1) movement from game playing to game making, (2) the emergence of educational game types that entail lower production values, and (3) a gradual shift in focus away from games for learning to an appreciation of the value of playfulness in learning. Closing her book, she asks, "Could we really move to a world where my imagined future becomes a reality?" and replies, "I truly hope so, but I suspect it will not be in my lifetime" (p. 190).

Whitton's prognosis may well result from confronting the present reality with a "cold hard look." Notwithstanding, I prefer to close this book on a more optimistic note, based on the premise of process philosophy that all things change (Chee 2014; Rescher 1996)—the only unpredictable issue being the timescale of change (Lemke 2000). A schooling system that becomes increasingly untenable

Y.S. Chee, *Games-To-Teach or Games-To-Learn*,
Gaming Media and Social Effects, DOI 10.1007/978-981-287-518-1_8

in a postmodern world characterized by fragmentation and weaknesses of the center must, in due time, give way to new forms of organization and administration. Commentators such as Collins and Halverson (2010) portend a "new system of education" driven by the needs of lifelong learning in the information age. This "new" system is manifested in the increased incidence of home schooling, workplace learning, distance education, and adult education. Collins and Halverson imagine that, in the absence of greater attention being paid by national governments to the transition between school and work, schools will be pigeon-holed into pursuing a narrower curriculum, oriented toward academic certification, and coexist alongside a host of non-traditional education providers such as for-profit learning centers, technical certification institutes, and corporate universities. The alternative facing schools is to rise to the challenge of reinventing themselves before this variegated landscape of learning becomes rooted irreversibly.

The near universal de facto culture of schooling mitigates against the value of playfulness in learning that Whitton (2014) argues for, even *without* the use of digital games. I can speak of this from personal experience. Whitton appears to concede that the incidence of game playing for learning will diminish, perhaps because she feels overwhelmed by the challenge of significant production costs associated with developing authentic games-to-learn such as the ones detailed in this book. However, I believe that such challenges can be overcome provided there is community will to do so. I address this challenge in relation to the issue of funding below. I fully endorse students learning through the activity of making games. However, no trade-off between playing and making games is necessary. Rather, the two should, in my view, mutually inform and strengthen each other within the broader context of helping pupils develop digital literacies (Lankshear and Knobel 2008).

A bright spot in favor of digital game-based learning lies in the heightening sensitivity of educators to the importance of fostering students' identities in this late modern/postmodern era. Whitton (2014) appears not to recognize this, because she limits her treatment of identity to avatar identity in the context of multiuser virtual environments. Stokes and Wyn (2009), however, point to the increasing significance of identity work in young people's transitions through education to work. They argue that in a globalized world characterized by unpredictability and rapidity of change, young people understand that gaining schooling credentials will not assure them of a job. They must now actively construct education and employment biographies that make them attractive in uncertain labor markets. In such circumstances, identity work is crucial. It involves the capacity to be reflexive, able to reinvent oneself in response to changing workplace requirements, and capable of constantly performing to establish self-worth and meaning in life. In the process, they must construct narratives that constitute their own biographical project. Storying one's life, however, is a learned practice. Authentic game-based learning, with its strong role identification characteristic, complemented with dialogic pedagogy, which supports personal sense making, can provide a crucial means for scaffolding students' understanding not only of academic subjects, but also of their own selves and lives. In this sense, digital games furnish a unique affordance that meets a pertinent educational need in the contemporary landscape of education.

Within present-day discourse on advancing innovative forms of technology-based learning, there exists a dominant thread on scaling-up exemplary educational innovations that have been shown to be successful on a small scale, and it applies to game-based learning as well. This discourse is especially prevalent within certain segments of the education community, such as the community defined by the learning sciences. The roots of this discourse emanate from an influential paper by McDonald et al. (2006). Positioning themselves from the viewpoint of policy makers and their concomitant concern for unambiguously determining "what works" to produce sustainable improvements in school-based learning across a diverse student population, McDonald and her colleagues cajole researchers to pay increased attention to "scale-up in education" (Schneider and McDonald 2007a, b). Scale-up research, they argue, must be based on randomized controlled field trials: their gold standard for establishing internal validity and generalizability of research findings.

However, closer inspection of the injunction to scale-up raises several disconcerting concerns. First, McDonald et al. conceptualize scale-up in entirely quantitative terms. They go so far as to endorse Slavin's (1997) algorithmic formulation that scale = number of students x time x impact. Second, they assume a naïve, cumulative view of how scientific evidence is gathered, rooted in the doctrine of positivist thinking: a thinking that presumes a linear trajectory of scientific development premised on an unwavering belief in cause–effect determinism derived from Newtonian physics (Doll 1993). Regrettably, the imposition of a scientific method drawn from the physical sciences on a realm of activity where human behaviors, values, and agency are paramount negates what it means to be human and disregards the moral and value-laden dimensions of the education enterprise. Third, such researchers manifest a tendency toward the use of technology to "bring about change for the better in *schooling*" (Tatar et al. 2008, p. 251) rather than in educating pupils. A critical stance toward the aims of education, especially in light of twenty-first-century demands, appears lacking. This lack of criticality is evident in the kinds of measures espoused: "measures of short-term effect and retention" and "measures of transfer" (Baker 2007, p. 47), despite transfer being a discredited construct owing to its cognitivistic assumptions (Packer 2001). Fourth, McDonald et al. stubbornly ignore the human side of school change (Evans 2001) referred to in the previous chapter. They appear enthralled by the techno-rationalistic worldview of high modernity, which extols the virtue of predictability and the power of control over uncertainty—outcomes that are not completely achievable in principle. Through the use of activity theory, Engeström (2011) exposes how overemphasis on technical rationality suppresses attention to the local dynamics of change, innovation, and resistance in the activity of schooling. Seen in this light, it is vital to support teachers' need for professional development and pay heed to the human complexity associated with the process of shifting teaching practice, as discussed in Sect. 7.2.

I now consider the related issues of funding the development of authentic educational games and that of product commercialization, based on my experience of developing the games and curricula described in Chaps. 4, 5, and 6. Given that the development of authentic games requires thoughtful and informed work in game design, programming, digital art creation, and curriculum development, the endeavor is complex and requires careful coordination. Working in a university, I was fortunate to receive research funding that allowed me to pioneer experiments with game-based learning in local schools. Much of the initial impetus revolved around constructing so-called point-at-able models of game-based learning that could be upheld to teachers as concrete exemplars of game-based classroom practice. Having now accomplished this goal, the next step in the broader challenge is to be able to have a sizeable core suite of such games for teachers to adopt so that game-based learning can evolve into a more mainstream phenomenon. It would not be feasible, clearly, to continue to draw on research grants to fund this next phase of work.

Industry players in the game development business, unfortunately, are ill equipped to develop educational games akin to the ones described in this book because they lack pedagogical expertise and a broader grasp of education that is needed to fashion new possibilities. My experience has been that, at best, game development companies resort to employing instructional designers as "experts" in pedagogy and content development. Predictably, the outcome of such development efforts is games-to-teach (content), representing the direct continuation of what we saw during the multimedia courseware era of computer-based learning. There is inadequate familiarity of games-to-learn (framed as performance based learning), a deficit that this book contributes to redressing. Apart from the lack of expertise, game companies in industry also face a shortage of capital to invest with a reasonable prospect of earning profit in the medium term. Most such companies depend on quick and sizeable sales as a lifeline to sustainability and to avert a liquidity crisis. Given these circumstances, it seems unlikely that commercial game companies will be able to fill the relative void in the authentic educational games market. What appears to be needed is a multinational consortium, or some such organization, that will fund and champion authentic game-based learning. Such a consortium would bankroll the start-up investment needed to develop the core suite of educational games and curricula referred to earlier. Essentially, the challenge we face is one of bootstrapping a new phenomenon into existence, concomitantly buying time to allow more success stories to emerge and a greater extent of teacher uptake to occur, until such time that the new practice attains critical mass and is normalized. To this end, given the nature of the innovation, the specialized expertise required, and the operation of economies of scale entailed in game production, it is essential that the fruits of game and curricula development be productized and commercialized for an international market. In pursuing this plan, it would be sensible to first focus on core curricular topics that are not country specific, and hence readily adoptable across the world. As a natural process of innovation diffusion, the expertise needed will, in time, dissipate into the mainstream game industry, creating a specialty that can sustain an ecology, not only of game production in industry, but also of routine game use in schools. The crucial question is: who is willing to take the risk involved and step into the breach?

8.2 Educational Opportunities

Looking ahead, we might anticipate a push for authentic game-based learning induced by creeping societal changes. The pathway and progression of change is unavoidably fraught with uncertainty and unpredictability. Any yearning for clarity and search for certainty, although understandable, would nevertheless be futile. Dewey (1929/2008) clarified a long while ago that the quest for certainty is pointless because "the object of knowledge is a constructed, existentially produced, object" (p. 168), not a discovered one; hence, it is always highly contingent. Natural, social, and cultural systems that constitute the bedrock of human life and life experiences are open systems. Our human understandings of these systems are socially constructed and subject to ongoing revision in light of new experience of occurrences that are anomalous with current understandings. Current developments in cross-disciplinary work point to an urgent need to shift away from sequential thinking so typical of atomistic linear cause-and-effect to embrace insights from complexity theory predicated upon the analyses of wholes, multiple subsuming systems, and intra-system relations (Davis and Sumara 2006; Trueit 2012). Taking the latter perspective seriously "forces" a reconstruction of the dynamic of change in terms of constructs such as emergence and self-organization, connectedness, diversity and redundancy, unpredictability and nonlinearity, coevolution, communication and feedback, open, complex adaptive systems, and distributed control (Morrison 2008). In these descriptors, we find germane ideas that can serve as a viable basis for reconceiving educational systems where change is regarded as the only constant. A methodology for influencing the course of change from an open systems perspective is that of the Change Laboratory (Virkkunen and Newnham 2013), which is predicated upon the tenets of activity theory (Engeström 1991, 2001, 2008).

Considering the learning futures that we face, Facer (2011) argues that the educational imagination of the last two decades has been dominated by that of a global knowledge economy fueled by international competition and sustained by digital networks. She argues, however, that this vision can no longer be considered sufficiently robust or desirable to guide education. The pervasive vision has taken on the status of a myth in that it now acts as an unquestioned cultural resource. It functions as a dominating narrative that allows educators, policy makers, parents, and other stakeholders to make decisions and take actions without ample and deep critical reflection of what is going on. However, this myth is contestable on the following grounds. First, the highly partial view of the future is presented as inevitable, uncontestable, and unchangeable. This view is not sustainable in light of the argument made in the preceding paragraph. Second, it offers a very biased view of technological change that is couched in terms of economics, at the expense of concerns for our sense of and worth attached to selves, community, and society. Third, the myth assumes that the primary, almost exclusive, function of education is to prepare young people for the formal economy. Fourth, it presents a profoundly anti-progressive account of the history of education: one that champions the *status* *quo* and upholds immutability. However, as we look forward to a future that is open and full of potential for the betterment of society, we ought not to be laden down with the yoke of dubious myth. We must do better than place blind faith in tenuous myth.

Thus, we should consider, seriously and pragmatically, the prospect of education alternatives to reboot the institution of school by transforming school values and culture (Kaplan and Owings 2013). For too long, we have had young people who "sit in classrooms, passively cooperating, even responding positively, but waiting for the bell. Although they do not actively rebel against school, they would rather do it differently" (Te Riele 2009a, p. 7). In a rudimentary sense, schooling is being reinvented all the time, as Tyack and Cuban (1995) argue, because good teachers reinvent the world every day for children in their classrooms. This reinvention, however, does not necessarily proceed in ways envisaged by bureaucrats who are engaged in macro-planning. Tyack and Cuban warn that the reform of teaching by remote control does not work well. To the extent that on-the-ground teachers are kept out of the policy loop in designing and planning school reforms, it is unsurprising that they drag their feet in implementing them. For this reason, Te Riele (2009a) advocates "inside-out reform" rather than top-down reform as the better way to overcome the deep grammar of schooling practice. She cautions against being either a pessimist or optimist in respect of school reform efforts and advises instead that one should be a possibilist, as first suggested by Max Lerner (cited in Lagemann 1992, p. 201):

> A possibilist would be able to approach educational problems with an eagerness to explore new ideas and practices, but without a willingness to be carried away by inflated expectations or promises…. A possibilist would profoundly understand the vital importance of education and the perpetually imperfect nature of the endeavor. Most of all, perhaps, a possibilist would recognize the degree to which education is enmeshed in the historic problems and the contemporary and future prospects of the society in which it is a part.

Concurring, Tyack and Cuban (1995, p. 136) add:

> School reform is also a prime arena for debating the shape of the future of the society. Such debate is a broad civic and moral enterprise in which all citizens are stakeholders. In recent years, however, discourse about the purposes of education has been impoverished by linking it insistently to the wealth of nations.

Based on the insights above, it is essential to engage the understanding and support of parents and the public when reform proposals challenge widespread cultural beliefs about what a "real school" should be and do. We ought to constantly remind ourselves of the vision of a good school propounded by informed, authoritative experts and critics such as Postman (1995), Postman and Weingartner (1969, 1973), Gee (2013), Macdonald and Hursh (2006), and others. We would also do well to be reflexively aware that, at least in democratic nations, societies choose their political leaders, and political leaders, in turn, implement schooling policies and programs that largely mirror the values that permeate that very same community. Consequently, depending upon the democratic model that the citizens of a nation install—whether elite, participative, deliberative, or some other—societies might be viewed as embodying the very kind of schooling their members themselves want. In this sense, they perhaps get what they implicitly ask for (Ydesen 2014).

In light of repeated disappointment with school reform efforts that are persistently unsuccessful (see, for example, Cuban, 2013), it is, notwithstanding, imperative that we maintain what Giroux (2004) refers to as an “educated hope” for a better future. Educated hope, he argues, must be seen as part of a broader politics that acknowledges the social, economic, spiritual, and cultural conditions in the present that make certain kinds of agency possible. Thus, hope is not merely a wistful attempt to look beyond the horizon of how things are in the present, but it is also a pedagogical and performative practice that acts as the basis for enabling human beings to learn about their potential as moral and civic agents. What hope offers is the belief that different futures are possible. In Bloch’s (1986) philosophy of hope, he argues that hope must be concrete, a spark that speaks to us in the world in which we now live by presenting tasks based on challenges of the present time. Hope is something *not yet* in the sense that it is a possibility, but it could be there if we could only do something for it (Bloch 1988). Hope is thus constituted by a discourse of critique and social transformation. Educated hope, from Giroux’s (2004) point of view, is a subversive force when it pluralizes politics by opening up a space for dissent, holding authority accountable, and becoming an activating presence that promotes social transformation. Its goal is not to liberate the individual *from* the social but to take seriously the notion that the individual can only be liberated *through* the social.

Te Riele (2009b) advances a pedagogy based on the philosophy of hope. Hope, she argues, must be complex, attainable, and sound. Hope is complex because education systems are complex systems, and so the agency of individuals and groups as well as the social structures that shape schools and society must be regarded seriously. Hope must not be merely wishful thinking, but it should be located between wishing and planning: something that is “agreeable, future, arduous, and possible of attainment” (Godfrey 1987, p. 14). And hope must be sound in that the alternative, hoped-for situation must be necessarily better. Any consideration of betterment invariably requires an ethical evaluation. Thus, sound hope is positively linked to human well-being. It is inherently social because it seeks “the flourishing existence of the other” (Godfrey 1987, p. 29). Te Reile’s pedagogy of hope draws upon four resources for its realization: a positive culture of learning, constant focusing on possibility, establishing a community of hope, and ongoing critical reflection of education practice. It is encouraging that McInerney (2007) finds evidence of “resources of hope” in schools to guide teachers in pursuing the goal of socially just schooling. One would wish that such resources, supported by critical reflection and the personal and professional agency of parents, teachers, and the broader community, are also available to foster uptake of performative game-based learning in the spirit of a pedagogy of hope oriented toward possibilities of educational growth of the kind espoused by Dewey (1995).

Just as Dewey (1920/2008) felt compelled to press for overhauling the metaphysical underpinnings of classical Western philosophy in his book *Reconstruction in Philosophy*, I hold that we, today, are likewise in dire need of reconstruction in education. For much too long now, educators, education administrators, parents, and politicians have been held in thrall by a misplaced metaphysics that has been consolidated and upheld by transcendentalist Kantian thinking. However, as Dewey argued, the extolling of Reason by analytic rationalism led to absolutism: the very opposite of contingency that is characteristic of all open systems. In his *Reconstruction*, Dewey pointed to changed conceptions of experience and reason and to the notions of the real and ideal. His philosophic reconstruction found fullest expression in his later works (such as Dewey 1925/1988, 1933/2008, 1938/1991, 1949/1991). Ross (2008) argues that, as a humanist, Dewey reintroduced the human into philosophy,

> …whose marble walls had traditionally housed forms, essences, archetypes, and reality, but not human activity. Dewey turned them all out. They were tenants surviving from antiquity and the Middle Ages and had to be replaced by *people* who acted on the strength of intelligence modeled on science. Henceforth, philosophy would be different and its results incalculable. (p. x, italics added)

Unfortunately, the Kantian worldview remains enshrined in contemporary thinking. Kant conceived of knowledge as being dependent on the human mind and all judgments as qualified by the nature of mind. However, Dewey and Bentley (1949/1991, p. 124) counter-argued that the concept of mind is redundant:

> The "mind" as "actor," still in use in present-day psychologies and sociologies, is the old self-acting "soul" with its immortality stripped off…. "Mind," "faculty," "I. Q.," or what not as an actor in charge of behavior is a charlatan, and "brain" as a substitute for such a "mind" is much worse. Such words insert a name in place of a problem…. The old immortal soul['s]… modern derivative, the "mind," is wholly redundant. The living, behaving, knowing organism is present. To add a "mind" to him is to try to double him up. It is double-talk; and double-talk doubles no facts.

The origin of philosophy, after the Greek tradition, arose from an attempt to create a rational justification for social tradition prevailing at that time. The philosophic universe had an aristocratic structure, which became feudal in the Middle Ages. Mirroring this characteristic, "[c]lasses and species did not flow into each other or overlap, nor were they equal; they fit easily into a hierarchy…. [T]he supernatural order in heaven in the Middle Ages was a kind of feudal hierarchy, meticulously arranged from lowest to highest. Not only did heaven mimic earth; earth also imitated heaven" (Ross 2008, pp. xii–xiii). Given this worldview, the intellectual construction of the world as comprised of entities fitting into a hierarchical structure emerged and grew dominant. However, the birth of modern science shattered this cosmos, and Dewey sought to reconstruct social understandings in light of science and ideas emanating from evolutionary biology. For Dewey, "[r]econstruction meant the application of intelligence (not Reason in the old sense, but the *kind* of observation, experiment, and reflection used in physical science) to human and moral subjects. Earlier philosophy had been pre-scientific, pre-technological, and pre-democratic" (Ross 2008, p. xix, original emphasis).

Applying this intelligence, knowledge is no longer a matter of discovering what or how things "really are," as though they were unchanging and inhabited a universe without us. Rather, they are what they can do and what can be done to them, ad infinitum. Thus, Dewey saw modern science as revolutionary because it brought about the understanding that the only "universal" phenomenon is that of process. As such, educational concerns are properly directed at human know*ing*, think*ing*, reason*ing*, problem solv*ing*, etc. If one remains fixated on "mind," then that absorption should be redirected to human mind*ing*, as Geertz (1973) asserts. Ultimately, the "old" philosophy "bakes no bread and Reason does not get flour on its fingers" (Ross 2008, p. xii). To overcome the inertness of traditional philosophical thinking, it is essential to locate thinking *in* human experience and action.

The aforementioned position is the cornerstone of the theory of situated learning, based on the account articulated by Lave and Wenger (1991). They argue that depicting a person as a primarily "cognitive" entity promotes a non-personal view of knowledge, skills, tasks, activities, and learning. In contrast, to insist on starting with participation in social practice suggests a very explicit focus on the person (not the person's mind or brain) as a *person-in-the-world* and as a member of a sociocultural community. This focus, in turn, promotes a view of knowing as activity by specific people in specific circumstances. Furthermore:

> A theory of social practice emphasizes the relational interdependency of agent and world, activity, meaning, cognition, learning, and knowing. It emphasizes the inherently socially negotiated character of meaning and the interested, concerned character of thought and action of persons-in-activity…. [The] world is socially constituted; objective forms and systems of activity, on the one hand, and agents' subjective and intersubjective understandings of them, on the other, mutually constitute both the world and its experienced forms. Knowledge of the socially constituted world is socially mediated and open ended. Its meaning to given actors, its furnishings, and the relation of humans with/in it, are produced, reproduced, and changed in the course of activity. (pp. 50–51)

Consequently, learning implies becoming able to be involved in new activities, to perform new tasks, and to master new understandings. It implies becoming a different person with respect to the possibilities enabled by the system within which the person finds him/herself. Learning involves the construction of identity that arises from being and becoming human (Stables 2012). Identity, knowing, and social membership entail each other. From a theoretical perspective, then, we come full circle and return to the fundamental conceptual underpinnings of this book, as articulated in Chaps. 2 and 3, because Lave and Wenger's construction of situated learning draws heavily upon Deweyan premises. Based on this perspective, there is no dichotomy between the physical world and the social world. Instead, the social domain is more complex than the physical domain and is continuous with it in a subsumptive sense (Dewey 1938/1991).

Moving forward, how can we intelligently realize the vast educational opportunities that authentic game-based learning holds open to us? First, a far deeper level of consideration must be accorded to learners viewed as social actors who learn in and through meaningful *activity*. The tight and inescapable coupling between knowing and the known (Dewey and Bentley 1949/1991), where the latter is conventionally thought of by laypeople as "knowledge," indicates that it is very unenlightened to extol subject matter learning, in the manner typically emphasized and carried out in schools, as a (if not *the*) primary goal of education. Indeed, Dewey (1990, p. 189) castigated:

> Abandon the notion of subject-matter as something fixed and ready-made in itself, outside the child's experience; cease thinking of the child's experience as also something hard and fast; see it as something fluent, embryonic, vital; and we realize that the child and the curriculum are simply two limits which define a single process.

Consequently, education reform must begin with curriculum reconstruction. In this regard, Dewey (1916/1980) pointed out several "evils" that flow from the isolation of learning method from subject matter. The first evil concerns neglect of concrete situations of experience, which are vital to learning-in-and-through-activity, as previously argued. The second evil concerns false conceptions of discipline and interest. Discipline is often perceived as a classroom challenge when pupils demonstrate lack of interest in ready-made subject matter that is highly removed from their own life experience. The threat of painful consequences or shallow attempts to motivate by creating excitement or pleasure (so prevalent in current discourses related to the need to engage students) serves only to mask misconceived notions of "learning engagement" held by those in positions of authority. The third evil concerns how the act of learning is made a direct and conscious end in itself; that is, students are "forced" to know subject content "for its own sake" rather than as means to personally relevant ends. And, finally, the fourth evil concerns the way in which teaching and learning method is reduced to a cut-and-dried routine based on mechanically following prescribed steps. Such thinking is based on two mistaken assumptions: assuming that there is one fixed method to be followed, and assuming that if pupils are compelled to comply with a certain form of response, their mental habits will in time conform to the desired answers. In fact, Dewey decried the practice of giving teachers recipes and models to be followed in their teaching as having brought pedagogical theory into great disrepute because doing so cribs the professional growth of teachers.

I believe that the theoretical and practical ideas that I have described in this book offer one (not *the*) way for moving education forward, within the context of a broader effort directed toward reconstructing education and by which fruitful education reform may be enacted. Grounded in Dewey's philosophy of pragmatism and directed toward redressing long-standing metaphysical confusion that has led to a considerably flawed construction of understanding related to human learning, a shift to inquiry based learning realized through performance pedagogy is proposed. These orientations seek to engender enactive, personally meaningful learning outcomes that empower learners and make them competent actors and participants in social and professional practices. The task we face entails evolving one facet of human culture to a new level: that of transforming the dominant culture of schooling into a newly invigorated culture of educating. There will undoubtedly be many stakeholders who will resist such a venture, viewing it as uncertain and risky. But all change (which takes place all the time anyway) is inherently uncertain and fraught with risk. As Powers (2000, p. 275) suggests, however, "progress is destruction with a compass." Guided by a reliable compass, it may be wiser, in this present age of fast-paced innovation and creativity (Araya and Peters 2010), to fix the prevailing system before it is well and truly broken. It is no longer adequate to train people "to follow a rule" (Taylor 1995) because that kind of behavior is the hallmark of unintelligence. The future is open and may be conceived as being "impregnated with possibility" and open to "multiple lines of flight" (Deleuze and Guattari 1987). Given that new possibilities based on fresh imaginaries for social good have to be *made* (Horton and Freire 1990) (and challenges that arise along the way dealt with) rather than merely found, will there be global leaders, national leaders, and education leaders with the requisite understanding, imagination, guts, and gumption to forge a new path in education? One would sincerely hope that, in our present day, such leaders do exist for the sake of our children, who deserve nothing less. Only time will tell whether the vision of an improved education future, as expressed in this book, will be acted upon and realized. A nation's education system is a reflection of its society: its strengths, weaknesses, capacities, and incapacities to enact needed change. Thus, we all bear some responsibility and have a role to play in creating a better tomorrow, in terms of education.

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