Translational Systems Sciences 9

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Simulation and Gaming in the Network Society

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Translational Systems Sciences

Volume 9

In 1956, Kenneth Boulding explained the concept of General Systems Theory as a skeleton of science. He describes that it hopes to develop something like a "spectrum" of theories—a system of systems which may perform the function of a "gestalt" in theoretical construction. Such "gestalts" in special fields have been of great value in directing research towards the gaps which they reveal.

There were, at that time, other important conceptual frameworks and theories, such as cybernetics. Additional theories and applications developed later, including synergetics, cognitive science, complex adaptive systems, and many others. Some focused on principles within specific domains of knowledge and others crossed areas of knowledge and practice, along the spectrum described by Boulding.

Also in 1956, the Society for General Systems Research (now the International Society for the Systems Sciences) was founded. One of the concerns of the founders, even then, was the state of the human condition, and what science could do about it.

The present Translational Systems Sciences book series aims at cultivating a new frontier of systems sciences for contributing to the need for practical applications that benefit people.

The concept of translational research originally comes from medical science for enhancing human health and well-being. Translational medical research is often labeled as "Bench to Bedside." It places emphasis on translating the findings in basic research (at bench) more quickly and efficiently into medical practice (at bedside). At the same time, needs and demands from practice drive the development of new and innovative ideas and concepts. In this tightly coupled process it is essential to remove barriers to multi-disciplinary collaboration.

The present series attempts to bridge and integrate basic research founded in systems concepts, logic, theories and models with systems practices and methodologies, into a process of systems research. Since both bench and bedside involve diverse stakeholder groups, including researchers, practitioners and users, translational systems science works to create common platforms for language to activate the "bench to bedside" cycle.

In order to create a resilient and sustainable society in the twenty-first century, we unquestionably need open social innovation through which we create new social values, and realize them in society by connecting diverse ideas and developing new solutions. We assume three types of social values, namely: (1) values relevant to social infrastructure such as safety, security, and amenity; (2) values created by innovation in business, economics, and management practices; and, (3) values necessary for community sustainability brought about by conflict resolution and consensus building.

The series will first approach these social values from a systems science perspective by drawing on a range of disciplines in trans-disciplinary and cross-cultural ways. They may include social systems theory, sociology, business administration, management information science, organization science, computational mathematical organization theory, economics, evolutionary economics, international political science, jurisprudence, policy science, socio-information studies, cognitive science, artificial intelligence, complex adaptive systems theory, philosophy of science, and other related disciplines. In addition, this series will promote translational systems science as a means of scientific research that facilitates the translation of findings from basic science to practical applications, and vice versa.

We believe that this book series should advance a new frontier in systems sciences by presenting theoretical and conceptual frameworks, as well as theories for design and application, for twenty-first-century socioeconomic systems in a translational and trans-disciplinary context.

More information about this series at http://www.springer.com/series/11213

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Preface

Simulation and gaming have been used in a wide range of fields from school children, university, and professional educations to policy exploration and social system sciences and moreover now have been drastically changing its features in the newly emerging worldwide network society, while taking over a large diversity by "mutation" and "adaptive radiation" such as serious games and gamification.

International networking activities of simulation and gaming study can be traced back to 1970, the first annual conference of ISAGA (International Simulation and Gaming Association) in Bad Godesberg, Germany; at the same time, Sage Publication started publishing a periodical academic journal *Simulation and Gaming* (former title is *Simulation and Games*).

In the 1970s, for simulation and gaming study, board games or mainframe computers have been frequently used. In addition, the appearance of the personal computer in the 1980s and the World Wide Web from the 1990s to the 2000s, namely, through the emergence and global spread of the Internet, and the establishment of the global-wide network society during the 2010s, along with diversification by the "mutation" of simulation and gaming, have successfully achieved "adaptive radiation" by themselves.

If the simulation and gaming study is reconsidered from the other aspect, it can be called as translational sciences, in which the real world is captured as a practice area, although the classroom is appreciated for important basement. Its feature characterizes in both ways communication between methodological insightful knowledge and clinical prescriptions of the real world.

This book consist of selected papers from the ISAGA/JASAG 2015, which was the 46th ISAGA annual conference hosted by the JASAG (Japan Association of Simulation and Gaming) during July 17–21, 2015, at Suzaku Campus, Ritsumeikan University, Kyoto, Japan, with the "Hybrid Simulation and Gaming in the Network Society." The articles are selected and peer-reviewed by the Scientific Committee from all of the papers presented or from invited keynote speakers at this conference.

The JASAG was founded in 1989 and hosted the 22nd Kyoto conference in 1991 and 34th Kisarazu conference. In this conference of ISAGA/JASAG 2015, about

180 participants and guests attended, with 100 from Japan and 80 from other countries. Sixty-six of paper and poster presentations were about simulation and gaming (see Appendix A).

This book adopts the "state-of-the-art" of simulation and gaming study systematically, by the selected 30 papers, and is comprised of five parts.

The first part deals with History, Theory, and Methodology. Masukawa's paper discusses the archeology of the origin of board games. Leigh's paper discusses a game for learning the philosophical problem of time recognition. Rizzi's paper discusses a few games for "icebreaking." Kamm's paper discusses live-action role-play as a performance of reality. Nakamura's paper discusses quantitative sensory evaluation of simulation and gaming. This part includes fields discussed over 50 years, but the reader will catch a glimpse of recent discussions by excellent researchers in these fields.

The second part is named as Classroom Fields. Kriz's paper deals with three semesters of class teaching and exercise using simulation and gaming in the series of the subject of systems management. Garcia-Carbonell's paper deals with literacy training for the virtual environment such as SNS. Fedoseev's paper deals with man-machine gaming in mainly engineering education. Numazaki's paper deals with education gaming for entrepreneurship based on the problem-based learning in mathematics education context. Tamai's paper deals with the trials of simulation and gaming in international politics classes. Picos' paper deals with gamification trials in Polish university education. Each paper describes about reflection and reporting practices in a variety of places in university education.

The third part is Business Fields. Hara's paper reports on the science of creative services in Japan. Klevers' paper reports a gamification of business processes in material handling. Mizuyama's paper reports a serious game for building supply chain. Harviainen's paper deals with organizational learning in how a large-scale online game works as an information system. Iwai's paper reports an international comparison among Japan, Russia, and Vietnam on corporate decision-making by using a business game. Each paper reports the current study to take in advance in the business field.

The fourth part is Policy and Planning Fields. Stephans' paper reports on board games on urban problems of the past and present and current computer games. Freese's paper reports a serious game about air traffic management. Hoogen's paper reports games in the railway, based on the discussion of innovation processes in sociotechnical system. Sadiq's paper reports a feasibility study of land readjustment project in Afghanistan, using simulation and gaming. Otsuki's paper reports simulation and gaming for lessons of the Great East Japan Earthquake. Cui's paper reports a metrical analysis of the damage and reconstruction in the forecasted Nankai Trough Earthquake. Every paper is a progressive report about policy or planning matters of social system.

The fifth part is referred to as Emerging Research Fields. Among simulation and gaming as research tools that have been applied in various fields, we selected the papers that prospected rapid development in the near future. Maeda's paper reports an effect comparison among China, Japan, and Korea on environmental education with the public goods game. Kitakaji's paper reports experiments on the effect of information in social dilemma situations with two public goods games. Bommel's paper reports a development of agent-based simulation platform that takes into account the human decision. Van der Hiijden's paper reports on simulation and gaming for dealing with health and safety in the Fab Lab. Olejniczak's paper reports a development of a knowledge broker game for enhancing the capability on evidence-based policy. Gu's paper reports an analysis through an agent-based simulation for systematic management of evolutionary knowledge.

We hope the readers can obtain an overview about the "state-of-the-art" of simulation and gaming study throughout this book.

In addition, we would like to express gratitude to Ms. Sayori Harada for her editing assistance.

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Part I
History, Theory and Methodology

The Origins of Board Games and Ancient Game Boards

Koichi Masukawa

Abstract This study explores the history of board games and game boards, beginning with a discussion of the origin of play and games. Then, it summarises ancient game boards from all over the world. Finally, it discusses the development and modification of these games over time. Some of the games disappeared, while others survived. Subsequently, new board games that are descendants of the ancient games emerged. Exploring the history of games is one way to explore human nature.

1 The Origin of Play

Homo sapiens invented tools at least 2.5 million years ago and painted animals on the walls of caves almost 35,000 years ago (Clottes 2008). Concerning the next question, 'Did *Homo sapiens* play?', this phenomenon arose approximately 50,000 years ago.

As Huizinga (1955) pointed out, '...it is precisely this fun-element that characterises the essence of play. Here, we have an absolutely primary category of life...' We may well call play a 'totality' in the modern sense of the word, and it is as a totality that we must try to understand and evaluate play. In my opinion, however, Huizinga did not provide a precise and concrete concept of play.

The recent observations of Dr. Alice Roberts (Roberts 2010), among other scientists, point towards the origins of play. The children of indigenous peoples play, although some of this activity appears purposeless.

Therefore, the second stage of play might be to play with purpose. Huizinga also remarked on the relationship between hunting and play. Humans may have experienced the 'fun' elements of play in the context of hunting success. In other words, play was not distinct from ordinary life. Even in a hunter-gatherer society, there was competition with respect to skills that could feature an element of play.

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2 Other Routes to Play

Our ancestors suffered from the vagaries of nature. These experiences may have led them to believe that their lives were controlled by supernatural powers, such as spirits or gods. Evidence of this belief can be seen in cave paintings or in the discovery of the figurine known as the ‘Lion Man’, estimated to be some 35,000 years old and speculated to represent a shaman. Other evidences in this regard could be the lion head human statues, dated to 35,000 years ago and found in adjacent areas. They are suggested to represent sharmans at that time. This kind of statue had been made for a long time.

Our ancestors used various methods in an attempt to determine the intentions of such supernatural beings, including examining the flight of birds or the internal organs of animals, as suggested by myths and oral tradition.

Subsequently, devices were used to explore the will of supernatural beings, such as shells, animal teeth, nuts, leaves, and flat stones. All of these objects are double sided, allowing for two different options.

As early as 10,000 years ago, astragalus bones were used to determine oracles. These bones have four sides, thereby expanding the available options from two to four and leading to more complex decision-making. They have been found in Europe, the Middle and Near East, Eurasia, and North America, suggesting an interesting synchronism of human behaviour. The bones represent the precursors of dice and are still used in some cultures.

In historical terms, the emergence of artificial dice is a relatively new phenomenon. The oldest dice were found in Palestine and the Indus River basin and date to around 3,000 BC.

3 The Invention of Board Games

Our ancestors improved the methods used to determine oracles by using a board with a row of squares or small holes; by following the row, they could move towards a small statue of a god or spirit. If they arrived at the statue, they believed that their request would be successful; otherwise, it would fail. To determine movement towards the statue, they used shells, astragalus bones, and other objects, because they viewed such movements to be beyond the control of humans (See also discussions by Culin (1975), Lüders (1907), and Schädler (2007)).

Various agents emerged who claimed knowledge of the oracles using these dice-like tools. This may have led to competition among such agents, or seers, probably in turn leading to games. It is at this point that a competitive element was added to play.

Despite this transformation, from a device used to see oracles to a playing board, the board itself remained essentially the same. Surprisingly, the Mayans and Indians still play a game that uses one of the most primitive forms of a one-row board (Verveeck 1998).

Fig. 1 Mancala, Jordan (Masukawa's original photo, taken in 1985)

4 The Oldest Game Board?

The oldest game boards, found in the Levant and dating back to approximately 7,000 BC, consist of two or three rows of holes in a piece of limestone. These two- to three-row boards are thought to be variations on the original one-row board (Simpson 2007). The meaning of this change warrants further consideration (Masukawa 1978). Two rows may be interpreted as corresponding to two routes, i.e. one for each player. Another interpretation is that such boards represent precursors to 'Mancala' (Fig. 1), a board game played in Africa, the Middle and Near East, and Indonesia.

Mancala boards have been found in ruins in Cyprus dating to 3,000 BC and in the Pyramid of Menkaure (approximately 2,500 BC) and temple of Karnak, dating back to ca. 1,600 BC. The origin of this type of board remains unclear, but it differs markedly from board games that use dice. To move, seeds or stones are placed in the holes in the board. Mancala has been played for thousands of years at least, with a variety of rules and boards used.

5 Ancient Board Games

Game boards that show strong evidence of being played upon have been found in ruins in Egypt, Mesopotamia, Crete (Minoan civilisation era), and the Indus valley, dating back to 3,000 BC. Although we can discern the influence of fortune-telling elements in these boards, the majority of them represent 'race games' that use dice, with the exception of Mancala. These boards can be categorised into five groups. The 'missing link' between these board games and those of the Levant is still being sought, although all are assumed to be race games that use dice.

Fig. 2 Wall painting at the Abu Simbel temples, ca. 1290–1224BC (Masukawa's original photo, taken in 1994)

Fig. 3 Game board engraved on the floor at the site of Palmyra (Masukawa's original photo, taken in 1985)

The following figures provide further examples of ancient board games. Figure 2 shows a wall painting at the Abu Simbel temples in Egypt. Here, Ramesses II is facing a Senet board, which was played for almost 3,000 years from the First Dynasty of Egypt to the Era of Cleopatra VII, with players believed to interpret their fortunes via the game play. Figure 3 is a game board engraved on the floor of the site of Palmyra, believed to be a type of leopard hunting game. In Fig. 4 are two

Fig. 4 Two games engraved on the road at the ruins of Ephesos (Masukawa's original photo, taken in 1984)

Fig. 5 Game of Alignment, engraved at Persepolis (Masukawa's original photo, taken in 1991)

game boards engraved on the road at the ruins of Ephesos, Turkey; on the left is a game of alignment, while the game on the right is unknown. Figure 5 is also a game of alignment, engraved in an open square in front of the temple at Persepolis. The board shown in Fig. 6 is engraved on the floor of the Temple of Apollo at Didyma, assumed to be a kind of war game although exact details of the game are unknown.

Fig. 6 Game board engraved on the floor of the temple of Apollo at Didyma (Masukawa's original photo, taken in 1986)

Fig. 7 Duodecim Scripta at Didyma (Masukawa's original photo, taken in 1986)

Figure 7 is a board of Duodecim Scripta, commonly found in areas that formed part of the Roman Empire, and is engraved on the floor of an early Jewish temple. Figure 8 is another example of this game, located in the ruins of a noble family home. Figure 9 is a relief on the wall in Borobudur temple in Indonesia that depicts the game of backgammon.

Fig. 8 Duodecim Scripta at Ephesos (Masukawa's original photo, taken in 1997)

Fig. 9 Backgammon board in the relief on the wall at the Borobudur temple in Indonesia (Masukawa's original photo, taken in 1999)

6 The Development of Ancient Game Boards

Our ancestors developed different types of game boards. Until approximately 2,000 BC, the following four types of board game were recognised:

1. War games for two players. These games did not use a die and were the precursors of checkers and Alquerque.
2. Alignment and configuration board games for two players without a die. Such games were the precursors of Nine Men's Morris.
3. A board game found in Jiroft, Iran, with twelve holes arranged in three rows. This game is thought to be the precursor of Backgammon. In addition, three variations (i.e. boards with 20 holes) have also been found, supporting the assumption that these games were played widely.
4. Subsequently, an encircling game with a board representing the ecology of wildlife was invented. In this game, a player with a smaller force aims to capture all of the members of the larger force held by the other player. Examples of this type of game include 'Fox and Geese' and 'Tigers and Goats'.

7 The Rise and Fall of Board Games

The majority of the ancient board games have vanished, including Chinese Ryu-pou, which was popular in 500 BC, Mehen, Senet (the game of 20 squares, Münchener Universtät schriften 1979), and the game of 58 holes. Several other games that were briefly popular have also disappeared, perhaps due to changes in the social environment and individual preferences.

New board games were subsequently developed and are still played. For example, race games using dice remain popular worldwide, including Parcheesi, Snakes and Ladders, the Goose game, Sugoroku (in Japan), Monopoly, and The Game of Life.

Encircling games, such as Go, are also popular and are characterised by a wide variety of names and boards. War games such as Checkers and Mancala also remain popular. Chaturanga was developed in the fifth century, perhaps as a means of incorporating training exercises for armies onto a board. It is the precursor of Chess and Shogi, war games in which different pieces move in different ways. Such war games are particularly interesting, not only because of their global appeal but also with respect to the artwork involved in producing the pieces (e.g., Murrey 1952).

8 Conclusion

Over their 5,000-year history, various board games have been developed and subsequently disappeared; numerous game boards have been created. Board games and game boards have changed according to the preferences of players: the social environment may also have contributed to these changes.

Exploring the history of board games and game boards involves studying transitions in human wisdom and sensibilities. In other words, such research explores humans themselves through the concept of play, which is indispensable to human life.

The history of play is the history of human culture. I hope that more researchers will join this field.

(Translated by Toshiko Kikkawa. Any mistakes are attributed to the translator.)

References

Clottes, J. (2008). *Cave art*. London: Phaidor Press.

Culin, S. (1975). *Games of the north American Indians*. New York: Dover Publications, Inc.

Huizinga, H. (1955). *Homo ludens: A study of the play-element in culture*. Boston: Bacon Press.

Lüders, H. (1907). *Das Würfelspiel im alten Indien*. Berlin: Weidmannische Buchhandlung.

Masukawa, K. (1978). *Board games*. Tokyo: Hosei University Press (In Japanese).

Münchener Universitätschriften (1979). Das Senet-Brettspiel in Alten Ägyptem. München.

Murrey, H. J. R. (1952). *A history of board-games other than chess*. Oxford: The Clarendon Press.

Roberts, A. (2010). *The incredible human journey: The story of how we colonized the planet*. London: Bloomsbury Publishing, PLC.

Schädler, U. (2007). Schicksal-Chance-Glück. Herausgegeben von Ulrich Schädler, Schweizerische Spielmyseum.

Simpson, S. J. (2007). The earliest board games in the near east. In I. L. Finkel (Ed.), *Ancient board games in perspective*. London: The British Museum Press.

Verveeck, L. (1998). Bul: A patoll; Game in Maya Lowland. Board Games Studies. Leiden: Research School CNWS

Bending Time: Using Simulation to Warp Perceptions of Time for Learning Purposes

Elyssebeth Leigh

Abstract At first glance 'time' is 'timeless', immovable and preset. However, when examined more closely, human perceptions – and uses – of time are variable and malleable, and simulations and games are particularly well placed to play havoc with those standard perceptions of time passing. For twentieth-century designers of simulation-based activities (and those who precede them), time was always a crucial determinant of the final structure. In the twenty-first century, technology has increased the complexity of time as an element in the design palette. This paper explores aspects of how simulation enables designer and educators to bend time to their will. Aspects of the malleability of time are explored, drawing on case studies of a number of simulation activities. Some of these began as face-to-face activities and were transformed into online role play formats illustrating that time can be 'adjusted' to suit different contexts. Problems and opportunities, which emerge from 'playing with time', are identified and explored. A casual consideration of time may cause it to appear fixed and sequential. This exploration illustrates how simulation creates temporary experiences of stretched or telescoped time. Reasons for doing so vary with the game designer's intentions, and how it is done is also variable. Educational users of simulation must understand the reasons why time has been 'played with' as well as the means by which the designer has done so. As technology continues to evolve, so will the human capacity to manipulate perceptions of time and all that goes with it. This chapter helps users of educational simulation to comprehend the importance of understanding how, and why, time is not fixed or immutable.

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1 Introduction

In the sci-fi classic *Ender's Game* (Card 1985), the central characters are children identified as amenable to intense training via simulation for the purpose of defeating alien life forms apparently threatening to invade earth. Writing in the 1980s, the author, Orson Scott Card, was imagining a scale of hybrid simulation technology that is not yet possible, but is now much more likely than it was at the time he was writing. In the story the 'game directors' manipulate the children's senses to intensify their training and speed their development. The activities described here were not designed for such dramatic conditions, but they do alter participants' sense of time and context – at least for a short while – in similar ways – with the goal of creating conditions to sharpen awareness and attention so that participants acquire new knowledge and capabilities in an efficient *and* effective manner. In this paper the focus is on issues of 'time' as used in a range of face-to-face activities – some of which have been adapted as online role play-based activities. In most cases they are precursors to the forms of hybrid simulation and gaming now available to the networked society. Their use here provides insights into some ways in which current technical trends are being built on the prior knowledge of human behaviour captured and embedded in non-technical forms of simulation and games that, in turn, were constructed using knowledge of human endeavour that is centuries old. In other words, technology of the hybrid and networked forms that we are now comfortable with are simply the next iteration of human creativity. In the activities explored here, designers 'played with time' for various purposes suited to the context being replicated in the action, just as hybridising forms allow us to do now. This work does not, by any means, exhaust the issues once attention is focused on 'time' in simulation. It is an initial exploration of some characteristic ways in which designers and educators make use of the 'bendable' nature of time. In doing so it specifically draws attention to ways that increasing awareness about particular aspects of life, as they live it in 'real time', may lead all involved to an understanding that 'life' and 'time' may not be what they thought it is.

2 What Is 'Time'?

> Nearly two and a half thousand years ago, Aristotle contended that, "time is the most unknown of all unknown things", and little has changed since then.
>
> . . . the ticking of the clock, the turning of the pages of a calendar . . . are just incidental **physical manifestations** of the underlying concept. Time is a ubiquitous and essential ingredient of both everyday life and all manner of academic thought, but its fundamental nature remains tantalizingly difficult to encapsulate. (Mastin 2014)

The strength of this assertion indicates that seeking conventional definitions of ‘time’ may not be of much help in exploring what ‘time’ is in simulated contexts and experiences. For example, the Stanford Encyclopedia of Philosophy entry on ‘The Experience and Perception of Time’ asserts that:

> The very expression ‘the perception of time’ invites objection. Insofar as time is something different from events, we do not perceive *time* as such, but changes or events *in* time. But, arguably, we do not perceive events only, but also their temporal relations.

This is one important factor for designers and educators to note, as they work on creating representations of time/life via games and simulations. What they are working with are space/time *relations*. The inextricably linked, relational nature of these elements comes into focus as participants emerge from an experience and begin sorting out their recollections and perceptions of ‘what happened’. In effect good designers, and expert users, of simulation are acutely aware of the array of possible linkages among conceptions of ‘time’ and ‘events’. Both designers and facilitators arrange design elements and manage the action to meet important learning goals or create experiences that help participants to rethink some aspect of what they usually consider to be ‘real life’. They are aware of familiar intrinsic sensitivities about time and have learned to alter them for extrinsic purposes.In regard to using ‘time’ as a design element, designers and users of simulation and games – especially in learning contexts – are challenging the:

> . . . deep intuition that the future is open until it becomes present and that the past is fixed. As time flows, this structure of fixed past, immediate present and open future gets carried forward in time. This structure is built into our language, thought and behavior. How we live our lives hangs on it. (Callender 2010)

Their focus, instead, enables them to operate in full awareness of the fact that

> . . . as natural as this way of thinking is, [it is] not reflected in science. The equations of physics do not tell us which events are occurring right now – they are like a map without the “you are here” symbol. The present moment does not exist in them, and therefore neither does the flow of time. (ibid)

In a well-designed simulation, ‘time’ has become an ‘as if’ quality – and is not anything like ‘normal’ encounters with ‘time’ in ‘real-life’ experiences. This can be confronting for participants who are initially unaware that their own intuitions about time are not immutable, until they encounter experiences challenging everything that has been familiar. One commentator on Callender’s exploration of time as a possible ‘illusion’ suggested that

> [time] may be subject to something like Heisenberg’s uncertainty principle where the more accurately you measure one attribute the more indeterminate the other(s) become. (Scientific American, May 2010)

For the purposes of game designers and managers, this observation is particularly important. Indeed almost all aspects of ‘real time’ are subjected to some kind of ‘shape-shifting’ manoeuvre in any design that is more than a few minutes’ long. So this particular notion that ‘measuring’ one aspect will contribute to the indeterminacy of others within the frame of the game is a useful one, to which we will return later in this paper.

It is possible to identify a number of 'elementary time experiences' as being fundamental aspects of the human experience of time. Among these Pöppel (1978) identifies the experience of

> (i) duration; (ii) non-simultaneity; (iii) order; (iv) past and present; (v) change, including the passage of time. It might be thought that experience of non-simultaneity is the same as experience of time order, but it appears that, when two events occur very close together in time, we can be aware that they occur at different times without being able to say which one came first. (Stanford Encyclopedia of Philosophy)

Charles Handy, a prolific writer on human society, focuses on something akin to this when he writes about the 'paradox of time' as part of his work on 'making sense of the future' (1993) and notes that

> We have made this strange commodity [of time] into a competitive weapon, paying over the odds for speed.

He explores how the paradox of having 'more time' (because of modern 'conveniences' and reduced work demands) leads to an [almost] simultaneous feeling that we actually have 'less' of it and is reshaping relationships and work patterns – among other things. This kind of paradox is one that humans seem to accept as an inevitable outcome of 'life', and while we may complain about its impact, we do not often see that we could resolve it in any permanent way. Rather we shift among options, and thus do not recognise that we are manipulating 'time' for our purposes in real life, and could make other choices. Martin Gardner's exploration of 'the arrows of time' (Gardner 1991) is a useful guide when endeavouring to position 'time' as something that is manipulable in simulations and games. He notes how strong is the perception that

> An arrow of time is always pointing away from what we call the past, and towards what we call the future.

He suggests that, to all intents and purposes, there is agreement about the existence of a 'direction' for time, but that anything more specific than a vague understanding of directional intent, is likely to be contentious. Heraclitus (von Oech 2001) was acutely conscious of 'temporal impermanence' – and his assertion that 'you cannot step into the same river twice' has survived down through the ages as a metaphor for the movement of time. He was reminding all who cared to consider his aphorism that the 'flow' has moved on and the river we step into today is not the water that will cool our feet tomorrow. Gardner notes that the concept of:

> The direction of time's arrow is uniform and omnipresent in the workings of our mind

despite this being, at best, a weak metaphor for what 'time' is actually able to do or more properly what we can do with 'time' when we are in different modes and moods. Time does not actually 'flow' like a river. To understand this, consider Gardner again

> It is not time that flows but the world. 'In what units is the rate of time's flow to be measured?' Asked the Australian philosopher J. J. Smart 'seconds per [what]. .? To say 'time moves' is like saying 'length extends'.

So it seems that it is not 'time' as such, but rather the 'workings of our mind' that is being tampered with, when we engage with a simulation and emerge from the experience of the simulation *thinking* that we know the measure of the minutes/hours that have past. As something to 'play with', time is a construct whose impact on us is both true and inevitable and yet, under certain conditions, an element that seems to have no absolutely shareable 'meaning' at all. Memory is something we rely on heavily, when we talk about 'time passing' and yet it too is notoriously unreliable. As Eisold (2012) points out:

> neuroscientists have shown that each time we remember something, we are reconstructing the event, reassembling it from traces throughout the brain. Psychologists have pointed out that we also suppress memories that are painful or damaging to self-esteem. We could say that, as a result, memory is unreliable. We could also say it is adaptive, reshaping itself to accommodate the new situations we find ourselves facing. Either way, we have to face the fact that it is "flexible."

Perhaps this 'flexibility' is something that simulation and games take advantage of, in ways that even designers are only just becoming aware of consciously. Since 'memory' is so 'unreliable', perhaps we do not access it in the same ways, when engaged in a simulation as we do when engaged in 'real life'. Coleridge proposed – in 1817 – that writers could make use of the human capacity for 'suspension of disbelief' to engage their readers in fantastical stories. Such a concept helps make sense of the ways in which participants may have such different experiences while operating within essentially the same contained space of a simulation.Thus 'time', 'space/place' and 'memory' are all interconnected in a simulation in approximately the same ways they are in real life with one key difference. By taking on the right (and responsibility) to play GOD (game overall director), the simulation/game designer has replicated apparently unambiguous elements such that the aspects 'life' and 'events' are believable yet also untrue and 'unreal'.This is undoubtedly a huge responsibility and one that some designers are far more aware of than others. When participants in a simulation accuse the experience of being 'unreal' or 'not like real life', they are saying that the designer, and/or the manager of the experience, has failed to create the means for them to engage in an adequate 'suspension of disbelief' for the length of the activity, which brings us back to the nature of the roles that 'time' may play in a simulation or game.

3 What Are Some of the Roles of 'Time' in Simulation?

As a design component in simulation, time is often intentionally hidden from participants, such that its task is conducted independently of their awareness. It may be condensed or expanded. It can be checked off at regular intervals or apparently ignored in the interests of play. It may be a major or minor component of an activity. Often it is scarcely noticed by the participants or shamelessly manipulated by the manager of the activity.

A scan of various books on designing games and simulations reveals less than might be hoped about what time is in simulation and even less on how to manage its tricky properties. For example, Fullerton (2014) refers to time as a 'resource' in a section on 'Dramatic Elements' and is alert to the possibility that perceptions of time can be transformed in games, noting that:

> Digital games are notorious for sucking players in for hours on end because they involve players in flow experiences that distort the passage of time.

They draw on Czikszentmihalyi's (1990) work on 'flow' to trace the dynamic relationships among challenge and ability and frustration and boredom that a game or simulation can use to create an 'optimal experience' for participants. Similarly Salen and Zimmerman (2003) include 12 references to time in their index and also draw on Csikszentmihalyi's model to describe ways that 'time' may be used in specific forms of play. However neither group of authors explores the slippery notion of what 'time' is.

Taking a different tack on helping designers and users understand the rules about time, Wills, Leigh and Ip (2011) identify four 'dimensions' within which time is manipulated in role-based e-learning. These are:

- The length of playing time allocated to the experience – how long will this last?
- How much time each role is allocated for action – how much 'air time' do stakeholders have?
- Time scaling – how many days within the game have elapsed for each cycle of action?
- Time location – is the time mapped to a historical period? The present day? The future?

Their contention is that combining various permutations of these four aspects of 'time' helps create the necessary degree of realism and fidelity for the final design. The four dimensions are treated in a very practical manner, and 'tricks' are suggested for novice designers to use as they work their way towards competence as designers. For example:

> 'Time' [contributes] to shaping the roles as they are enacted, while also being constructed as an 'organising parameter' to shape the progress of the activity.
>
> If a role play occupies only a single session there may be a need for tight constraints on how much each role contributes. If it is to occur over several sessions, or weeks, of real time then the constraints may be quite different. Decisions about time are interdependent with all other elements in a design and sometimes there will be no conscious decision, since it will have been 'made for you' by the way other factors and organising parameters are combined.

It is the interdependency that is most important here. 'Time' is not separate from other elements in the design, and any change to a component will affect, and be affected by, all the others. An example of this is the intrusion of 'real time' into simulation 'time' occurring when life proceeds as normal in the intervals between simulation sessions. Some participants can apparently move effortlessly between 'real' and 'simulation' episodes, but others find it difficult to make smooth transitions between them.

Designers – and managers – must be alert to this discrepancy among individual experiences. Those attuned to the impact of 'time' as a design principle make every effort to ensure that they use 'time' in ways that align with 'reality' while taking participants on a journey 'out of time'. They hold 'time' as a continuously active factor in their mind as they 'play with' the other components of their design. But, in that paradoxical way noted by Charles Handy, they are not really even doing that in a sequentially ordered way! A visual metaphor may help to show how good designers manipulate 'time' to ensure that its role is an effective and efficient element in their final product. An image made famous by William Ely Hill concerned his version of a 'trick' image which actually contains two quite different perspectives. His image was called 'My Wife and My Mother-in-Law' and was first published in Puck Magazine, in 1915. It is used by psychologists to illustrate the paradoxical fact that, as we look at the image, we see first one, then the other face of the women named. But we cannot see them simultaneously – even though we know they are both there. Similarly designers need to pay attention to time in a manner that makes it 'forgettable' while influencing each of the other design components. The 'trick' in Hill's picture is that we 'know' there are two women depicted here, but our visual perception will only allow us to see one at a time. We hold 'true' the knowledge of the two depictions, but only 'see' one. And we do not puzzle over this, too much – it is something that 'just is'. Doing the same 'trick' with time is less comfortable for many.

When we are not closely examining the question of 'what is time', we think of it as sequential and structured and do not question that it is 'passing' in an orderly and stable manner. As we pursue this exploration, we are seeing that 'time' is both stable and predictable (each minute follows the one before) and yet is also slippery to manage and inevitably unpredictable in its impact on lives and learning. Like the image, they coexist, are inextricable and yet are never visible in the 'same space' according to our perceptions!

4 How Does the 'Paradox of Time' Work in Simulation?

By thinking of time as a 'paradox', it is possible to use incidents from individual iterations of particular simulations to illustrate how they help individuals 'bend time' to their own learning. Such incidents may be relevant only to the individual/s involved or may influence the overall outcome for all participants. These case studies are selected from our observations as managers of simulation. Each one is relevant to a particular perspective – designer, participant or session manager – and offers different perspectives on how 'time' behaves for those involved. While each is a singular episode, collectively, they provide a glimpse of the infinite possibilities that can emerge from crafted and deliberate use of 'playing with time' in simulation for particular purposes and goals.

4.1 Deluge: Time and Space Displaced

Deluge (in an unpublished, undated document) was designed to provide student welfare workers with a 'post disaster' experience as part of preparing for future roles in community emergency recovery plans. The scenario opens at the moment when their 'town' is about to be flooded to a depth of 15 ft, requiring them to plan how to remain safe. One evening it was being held in a college carpentry workshop where the lighting was poor. All the students were female, so an angry male voice came as a surprise to the session teacher and the activity manager who had withdrawn to a distant corner, to avoid influencing participants' actions.

Hurrying to the spot where the voices were raised, the session manager found the building's caretaker angrily remonstrating with the students. She turned away from their activity and focused on his issue. The students were rearranging the furniture (very heavy carpentry benches) and this was not supposed to be done. He was being reassured that everything would be returned to its exact place, once the session ended, when an amused female voice came from overhead. "Look at that silly man" said the voice "he doesn't know he's 15 ft under water!"

They had somehow lifted one heavy workbench on top of another and were sitting on top planning their next move, calmly looking down on someone whose unexpected presence they had incorporated into their 'story'.

In terms of real/'time' and real/'space', he was in a gloomy workshop where some upstart students were disturbing his neat and tidy world, while the students were in a rain-sodden world, successfully rescuing themselves and others from an impending flood. The session manager steered the caretaker out the door, with promises (duly fulfilled) of returning the room to its usual state, and returned to the scenario where the subsequent debriefing was mostly concerned with the survival strategies planned by participants. It was 'as if' the caretaker had sunk, without trace beneath the waves of the flood, and had disturbed nothing. For a brief moment, the 'other face' of time in such a situation surfaced. 'Real time' and 'game time' collided and 'game time' won, for the purposes of the intended learning outcomes. The incident has probably long since vanished from the awareness of students and caretaker while creating an indelible memory for the session manager and influencing the handling of many ensuing collisions of 'time' during simulation activity.

4.2 XB: Allowing for the Time Lag

One designer (Putzel 2010) – who understood that participants in an organisational behaviour simulation would not all be 'on the same page' at the same time – dealt with the likely consequences of time slippages in an interesting way. Understanding that the process could cause time lags in individual comprehension, he devised ways to help participants 'loop back in time' enabling them to review initial impressions.

The idea of everyone being 'on the same page' implies a belief in the *possibility* of simultaneous awareness of, and mutual agreement about, specifics of 'time' and 'place' in interactive contexts. This designer appreciated that it was unlikely such conditions would often occur. So he devised a process incorporating a means whereby 'time' could run 'forward' (scheduled meetings/agendas), 'backwards' (requirements to revisit past events and 'rethink them' to update perceptions about all the activity) and also 'loop back' around the entire experience (assessment requirements include weekly reports reflecting on what I did, what happened, why, what did I learn and what can I do next to improve future outcomes).

Assigned roles enabled participants to interact simultaneously in different parts of the space. There was no waiting for turns, so in a 'lifelike' manner, participants were propelled forward 'in time' while required to hold in memory observations and emotional responses to actions and interactions for reporting on, in sufficient detail, during the forthcoming week. These 'memos' were fed into the work cycle for analysis as part of each week's work. In this simulation – 'XB – Manual for a Learning Organisation' – time was construed as a very malleable element, constantly adjusted and revisited. The design goals were focused on enabling participants to learn about their actions and reactions, their impact on others and how to manage others' impacts on them. To achieve these outcomes required constantly adjusting perceptions and using the 'real time' available in each class session (plus out-of-class study time) to revisit, revise and rewrite experiences and perceptions.

4.3 Riftraft: Bending Time to Generate Insights

To achieve completion within a preset limited time frame, RiftRaft (Leigh and Chantler 2001) extensively confines time available to participants differently in each of three rounds of action. In round 1, all participants have an equal voice in their assigned groups, but a short time within which to build a 'common cause'. The second round is a meeting of group representatives, and one individual from each group has 3 min to speak and may not interrupt others – questions of clarification are allowed, but no debate or discussion. This 'take it, or leave it' round has two purposes: (a) to share information and (b) to create tension. In the final round, a specific time constraint is applied 'you must agree your collective decision within 5 minutes – or the funding will be withdrawn'. However the manager has control over this 'time limit' and can extend the limit to achieve a resolution before the debriefing.

When such an extension is revealed during debriefing, participants are always surprised. Their brains were told 'five minutes only', and as far as they are concerned, that is all the time that has passed. Prior constraints and demands for quick solutions have sufficiently distorted perceptions of time that such adjustments remain unrecognised.

Early on in RiftRaft 'time' is constrained and participants are 'harried' into making quick decisions. When constraints are lifted, participants continue working to the initial set of conditions and do not notice how their perceptions are not aligning with the actual passage of time. The purpose here is to focus attention on the way that use of 'time pressure' can cause a loss of awareness of actual time and lead to impetuous choices and/or incomplete/inadequate decisions. During the debriefing participants are encouraged to identify factors impinging on their loss of awareness and to consider how to watch for and prevent their continuing impact on behaviours and responses when under pressure.

4.4 Riddles: Where in Time Was He?

'Riddles' (Watson et al. 1981) is a communication activity about working in groups. Participants must complete a team task and simultaneously contribute to a whole group goal. The latter aspect is announced, but usually fades rapidly from view as attention to team-based tasks dominates activity. Learning outcomes usually include (a) increasing awareness of the ease with which we can lose sight of the 'big picture', (b) becoming more alert to intervening factors that may distract attention from the goal and (c) skills needed for working collaboratively in a covertly competitive environment.

It is a fast-paced activity in which participants focus on achieving 'their own' goal and inexorably lose sight of larger outcomes. That was not true for one participant who seemed to enter an entirely different 'time-scape'. As the group settled into debriefing, the opening question of 'what did this bring to mind for you?' led to his excited outburst 'Now I know why the United Nations doesn't work!' As this was part of a programme for bank accountants, there was amazement – even shock. What on earth did this activity have to do with the United Nations?

Then he explained. As he entered the activity with his team, he was puzzling about a recent failure of the UN. To him this was far more important than a trivial office squabble represented by the activity. Everything he saw and experienced was therefore viewed through the lens of his own personal conundrum. He could thus describe the behaviours of his peers – who had stolen clues, hidden information and lied – in terms of behaviours exhibited in news about the UN. To him the activity was a powerful lesson about world affairs. His 'time' in the activity had shifted him out of the bank's training facility and into a far larger context, which was nevertheless being replicated before his eyes. None of this was evident during the action.

As he returned to the present, and explained his exclamation, all those present were drawn into that bigger picture and away from the trivial present. For a while, 'time' took on a different dimension as they looked around at this comfortable learning space and thought about that crisis he was evoking for them.

4.5 *Furnishing Your Home: Changing Roles and Adjusting Thinking*

The simulation called ‘Furnishing Your Home’ (Plaisier 1980) was developed to aid members of three church denominations work through a complex amalgamation. In the activity, participants become ‘families’ of five (dad, mum, grandparent, teenage child and pre-teen child) and use scissors and paper to ‘furnish’ a three-bedroom home in 30 min. Then the activity manager announces that half the homes must be demolished and their occupants are to be accepted into the homes of those not affected.

Issues of equity, family relationships and acquiring and surrendering physical possessions are surfaced by the activity. And occasionally something happens that is outside all the usual expectations. And ‘time’ and ‘timing’ are almost always the trigger for these. On one occasion there were 39 participants, so one ‘family’ began with four members, but a late arrival was accepted into the group. Play continued, the ‘switch’ happened and noise levels rose as families adjusted to the new arrangements. In the midst of the chaos, two people took up residence on a convenient couch, away from the action. One was the latecomer who, it turned out, had been inducted into her ‘family’ as dad’s girlfriend (the family had explained away mum’s absence by ‘sending her on a world cruise’). She’d had a terrible time being harassed by the ‘grandparent’, who was the ‘parent’ of the absent mum! The other person on the couch was the ‘dad’ in the family which had been assigned to house this already ‘dysfunctional family’. He and his actual work boss were members of the host family and he’d been assigned the role of ‘dad by his boss, who then became ‘mum’. The announced intent was to help ‘dad appreciate the difficulties of being a boss’. Despite this, the boss had been so domineering that ‘dad’ felt overwhelmed. When the two families met, these two recognised ‘kindred spirits’ and decided to ‘elope’ to the couch where they serenely observed the action.

The debriefing was hectic as groups explored experiences of ‘merging’, or ‘taking over’ or ‘being submerged’ in each others’ housing arrangements. The two ‘absconders’ reported their experiences. Then everyone went home. It was 11pm on a very cold evening as everyone hurried to bed. Late next morning the two men found the activity manager and said together ‘You don’t know what you did to us!’ It turned out that the simulation had almost perfectly replicated behaviours in their workplace, and ‘mum’ was mortified to learn of the gap between his perceptions of himself and his actions. After the activity, ‘time’ had stood still for them both, as they sat in a car on a very cold night and examined in detail how 45 min of ‘play’ had unravelled their working relationship. Fortunately it had also repaired embryonic faults that could have turned into irreconcilable differences. Their memory of time in the activity was hazy – but their determination to build a different future was undoubted. For them, the happenstance of a late arrival and random reassignment of families had provided a ‘moment out of time’ when they could recalibrate everything about how they worked together.

5 Conclusions

Awareness that minds adjust perceptions of time to fit experiences is a key factor for those who use simulation for learning. Educators using simulation must understand such perceptions can affect actions without participants' prior knowledge. It is a vital competency to be able to recognise the likely impact of the use of time in a simulation and prepare to manage people who are unsettled by the sudden impact of finding that 'time' is no longer what they had understood it to be. Simulation designers must understand that 'time' is a component that can be easily 'bent' to suit 'real-time' constraints (e.g. 1 min can represent an hour), but when this is done, they must provide future users with an indication of the rationale for their design choices and identify issues they think might arise as a result.

References

Callender, C. (2010). *Is time an illusion? The concepts of time and change may emerge from a universe that, at root, is utterly static*. Scientific American, June 2010. http://www.scientificamerican.com/article/is-time-an-illusion/. Accessed at 28 Mar 15.

Card, O. S. (1985). *Ender's game*. New York: Tor Books.

Coleridge, S T http://en.wikipedia.org/wiki/Suspension_of_disbelief

Czikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience* (p. 93). New York: Harper & Row.

Eisold, K (2012). *Unreliable memory. Why memory's unreliable, and what we can do about it*. Psychology Today Mar 12, 2012. Accessed 28 Mar 2015.

Fullerton, T. (2014). *Game design workshop: A playcentric approach to creating innovative games* (3rd ed.). Abingdon: Taylor & Francis.

Gardner, M. (1991). *The ambidextrous universe – left, right and the fall of parity*. London: Penguin.

Handy, C. (1993). *The empty raincoat – making sense of the future*. London: Arrow Books.

Leigh, E., & Chantler, D. (2001). RiftRaft. In E. Leigh, & J Kinder (Eds.). (2001). *Fun and games for workplace learning*. Sydney: McGraw Hill.

Mastin, L. (2014). *Exactly what is time?/An investigation into the nature of time*. Accessed 28 Mar 2015 at http://www.exactlywhatistime.com/

Plaisier, T. (1980). *Furnishing your home* (unpublished).

Pöppel, E., et al. (1978). Time perception. In R. Held (Ed.), *Handbook of sensory physiology* (Perception, Vol. VIII). Berlin: Springer.

Putzel, R. (2010). *XB – manual for a learning organization*. Colchester: St Michael's College.

Salen, K., & Zimmerman, E. (2003). *Rules of play*. Cambridge, MA: MIT Press.

Stanford Encyclopedia of Philosophy. (2009). *The experience and perception of time*. First published Mon Aug 28, 2000; substantive revision Tue Nov 17, 2009. Accessed 28 Mar 2015.

von Oech, R. (2001). *Expect the unexpected*. New York: Free Press.

Watson, H., Vallee, J., & Mumford, W. (1981). *Curriculum development centre*. Canberra: ACT.

Wills, S., Leigh, E., & Ip, A. (2011). *The power of role based e-learning*. London: Routledge.

Eat the Cabbage, Kill the Wolf: When a Game Becomes a Useful Tool for the Simulation of Communication, Information and Decision-Making Processes

Paola Rizzi

Abstract The point of departure for this article is that it is difficult to use defined and structured gaming simulations in introductory sessions for negotiations, organisation of teamwork or meetings (in urban planning, community planning, community visioning, etc.) which should stimulate for the active participation. In fact their use demands aids and materials which are not always available, especially in short periods of time.

The activities of icebreaking, if they are not used just as a warm-up but as an "introduction" of topics and problems which are the topic of these events, allow a more interactive and stimulating approach to the following procedures.

1 Introduction

Nec porro augendis rebus spatio foret usus
seminis ad coitum, si e nilo crescere possent.
For bodies to grow time would not be needed,
for seeds to unite, if they could grow from nothing.
(Titus Lucrezius Carus *De rerum natura* Book I v. 184–185)

2 Knowledge and Metaknowledge

It is not the right place to discuss the theory of knowledge but we find it useful to say just a few words about metaknowledge, metascience and metalearning.

We assume that knowledge is constructed, even though a discovery plays its role in this process. The construction of new knowledge starts from observations of

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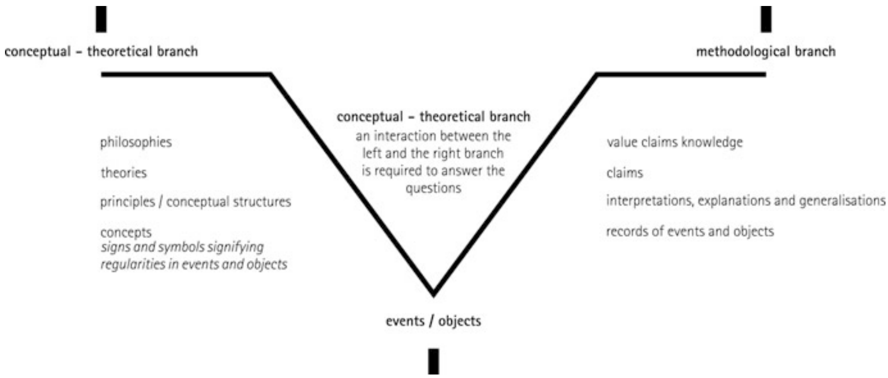

Fig. 1 Heuristic representation of knowledge according with Gowin (1977)

events or objects. These observations are guided by concepts which we already have (Novak and Gowin 1984).

We also have to make a distinction between cognition and learning, two terms that are often confused. The former is a public and collective process, the latter is personal and individual.

The process of constructing the knowledge is particularly relevant because it is the basis for the hypothesis of the use of games as metaphors of systems. It is a heuristic process as it is well shown by the representation designed by Gowin (Gowin 1981; Novak and Gowin 1984-Fig. 1). It emphasises the interaction of conceptual and methodological elements.

Metaknowledge has been the object of reflection since the antique times: Socrates, Plato and Aristotle dealt with the nature of knowledge and the act of learning. Quick growth in production of scientific knowledge was a stimulus for the studies on the structure of knowledge as well as on the process of production of knowledge and metaknowledge.

Knowledge obviously involves learning as the basis on which the individuals work out their own and characteristic meanings (Novak and Gowin 1984). The theory proposed by Ausubel contrasts two patterns of learning: meaningful and rote learning. In the process of rote learning, knowledge is gained through memorization and it is incorporated into the knowledge structure without any interaction with it (Asubel 1963, 1968; Ausubel et al. 1986). In this context Novak and Gowin (1984) identify different levels, from passive to strongly meaningful, as a response to different teaching strategies. They distinguish between reception learning and discovery learning. In the former the information is transmitted in a linear and direct way; in the latter the learner chooses in an active way the information to be learned and thus it becomes an autonomous process (Fig. 2).

Regarding the levels of learning, if we consider metaknowledge and metascience, we have to take into account metalearning: “that is what regards the nature of learning or learning about learning” (Novak and Gowin 1984). This is the

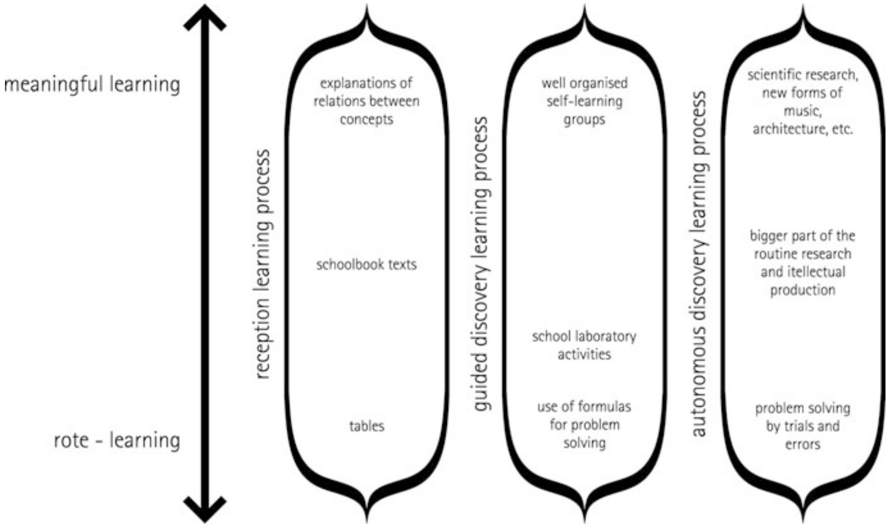

Fig. 2 Relation between teaching strategies and types of learning (Adaptation from Novak and Gowin 1984)

meta-level that we look at in order to classify the use of games as metaphors of simulation.

2.1 Learning and Gaming Simulation

We also have to recall the concept of the gaming simulation that we use. Compared with a multitude of possible interpretations, our proceeding is based on the concept of GS which is quite consolidated. First of all we prefer to use the term gaming simulation, not simulation game: gaming simulation preserves the nature of the game but adds the conscious world of simulation and modelling. The concept of gaming simulation used is as a gestalt (Duke 1974) that includes a significant model of reality (simulation) put in action (rules of the game) by decisions of the participants (players/roles). According to Duke (1974) gaming simulation is a "situation room" where usually a physical, iconic or conceptual map is provided and is kept current so the dynamic of this process is maintained by the updating. But GS in addition to the referred system "will have a series of scenarios depicting possible courses of action. Various decision-makers will be represented by humans acting out significant roles. By acting out 'what if' situations, alternative futures can be explored" (Duke 1974).

In practice the term simulation may have different connotations, depending on a practitioner's background. The economist and mathematician will likely be more familiar with predictive simulations, while sociologists and experimental psychologists will tend to use simulations as experimental tools.

In these definitions the aspect of experience is strictly correlated with simulation: we simulate and by simulating we make an experience regarding what the simulation represents. One of the questions regarding this sequence is: certainly simulations of algorithms regard the algorithms that they contain but even if a relevant part of the simulation is experience it is not sufficient for saying that the experience of the simulation regards the experience that it contains.

> Experiential simulations teach us that some representational designs convey conventional representational content and some do not. (. . .) simulation as play forces an awareness of the representational process – semiosis – and how dependent our epistemologies are on the biological mechanics of representationalism. In re-presenting the representations of the real world, simulation leads us to question those representations and, ultimately, assign reality elsewhere. Simulation may be truly valuable and unique only insofar as it is about the otherwise hidden reality of the semiotic process (Myers 1999).

Coming back to the problem that we have posed at the beginning: in many cases we do not have time to use a complex and realistic simulation or we do not have at hand one suitable for the topic. Our experience suggests that in such cases a great resource may be the use of actual games, normally used as icebreakers or warming-up activities, as metaphors of the system of reference. One of the risks of gaming simulation is related to the fact that it is on self-referential systems, which can easily make them so distant from the reality that they will become purely artificial. Why not reverse the problem and take something that is artificial and clearly self-referential and use it as a translation of the real world?

3 Play a Game as a Metaphor: The Case of *Goats & Cabbages*

The game *Goats & Cabbages* shows us how or rather which way we shouldn't use games connected with psychology or physical activities. They are excellent for icebreaking, but very often they are perceived as a nice and funny beginning that does not have any connection with what is going to come later.

The author during her work as a teacher and trainer and also in her scientific research has observed in which way the potential and the "metaphorical" nature of many games, including the commercial ones, can be used, in a specially prepared debriefing phase, to adapt their results for the purposes of the course, seminar or meeting.

Every game implies by its nature processes of communication, codification/ decodification of information and, in the end, a decision.

All the parts identified and structured will allow us to create a small, mobile library of simple games, both easily available and user-friendly, which would be always at hand.

The intention of presenting the study case is not to impose the first elements of this library. On the contrary it should encourage game designers to construct their

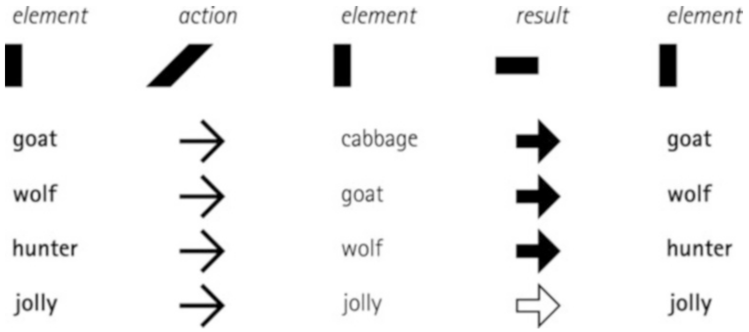

Fig. 3 Elements, actions and transformations of *Goats & Cabbages*

own collection, according to their specific needs: for education, participation or related to their discipline or scientific research.

3.1 The Game

Goats & Cabbages[1] is a strategic game inspired by the famous riddle of the goat, cabbage and the wolf. It is in fact about saving the goats and the cabbages, but also about saving the poor wolf from the hunter. The goal of the game is to cover all the 64 fields of the board by taking one by one the pieces, of five kinds, and by putting them in the way, if possible, so that they “do not eat one another”. While doing it we have to remember that (Fig. 3):

The level of difficulty of the game is determined by the number of available pieces, in particular those of unarmed hunters. Depending on the chosen level of difficulty, the player has from 10 to 16 pieces of cabbages, goats, wolfs and hunters and from 6 to 0 disarmed hunters. The disarmed hunters are the most important pieces and, except for sophisticated strategies, they should be played at the end when the board is almost full and when it is difficult to place the remaining pieces.

In each case it is the player’s concern to save the pieces and to sacrifice as few as possible to obtain the strategic goal.

It is important to know how the pieces “eat” and “are eaten”. First of all they can only eat in vertical and horizontal lines, never diagonal. On the lower levels of difficulty, the game has many solutions. On the highest level (level 7), the player can lose only one piece. If he loses more than one, the game will not be concluded. In each case, on this level, it is not always possible to cover all the grid of the board.

The points are calculated taking into account the level of difficulty, the number of pieces lost and those placed on the board.

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[1] *Goats & Cabbages* (1994) is a videogame designed and realised by Giovanni Monasteri

At the end of the game, when all the fields of the board are covered, the programme displays a message informing on the success of the project.

3.2 When and How to Use It

The game is very suitable for conflict situations and for negotiation in the contexts of inequality. The characteristics are a finite system (the game board), definite and not renewable resources; the actions and decisions have an immediate impact and there is no possibility to move one step back, except for the last move (but in this case you lose points anyway) and the roles have different functions, competences and power.

It was used in many different contexts and with various objectives: international scenarios (in a mixed group of American and Polish students with regard to terrorism and the future war in Iraq), cooperation between various actors in participative urban planning (groups of experts, citizens and administration), cooperation between various enterprises and intercultural communication. In each example the game was carried out in a different way: the supports were different – the board was shown in different ways and there were different construction rules.

3.3 Some Cases of Goats & Cabbages

The session of G&C was carried out with a group of students of the first year of Collegium of Zakopane. They were mostly young people, right after high school. The topic of their course at the Collegium was European integration (Rizzi 2003). The gaming session was a part of their 2-h lesson on gaming simulation as an instrument of communication and negotiation.

A modification to the game was introduced: each group was represented by a colour instead of a symbol. In place of cabbages we had a group of “greens”, goats were blue, wolfs were red and hunters were black. This change was introduced in order to change the way the players perceived their role. Instead of a more figurative representation which would bring associations with the real life (goats eat cabbages), we had an entirely abstract image.

Generally during the whole game, the players had an aggressive attitude and it seemed that they didn’t see much need for cooperation.

The most active group were the “blacks” – hunters. It was surprising that it was them to make the first move and to look for the alliance with the “blues” – goats. In the second negotiation round, the players were given three Jollies – disarmed hunters – pieces which role is to create a kind of barrier. They had to decide together where to place them. The outcome of the negotiation was quite surprising. Instead of taking the decision together, the groups decided to “distribute” the pieces among them. Three groups separately decided where to put “their” piece while the "red group" – wolfs – renounced to their piece. They explained that it wouldn't help them anyway. In fact they were the team who lost the biggest number of their pieces and at the end of the game "wolfs" were almost entirely extinct.

During the debriefing the students were told that the result of the game was very poor because they failed to achieve their common goal. They were asked questions about the relationship between power and responsibility which brought them to see the parallel between the game and the political situation in the world.

Another gaming session of G&C was organised in Kraków after a conference dedicated to the problem of immigration and immigrants in Europe. It was attended mostly by students of the course on gaming simulation, who already knew the game. However there were some people who played it for the first time. The game was quite equilibrated and a fairly high score was achieved. It was mostly due to the fact that the players already knew the mechanism of the game. Moreover even those who played it for the first time had a very cooperative attitude, especially in the second half of the game.

After the game one of the players observed that the little trick was that the names of the teams: cabbages, goats, wolfs and hunters brought to the game antagonisms, which existed in the real life. Therefore his first reaction was to fight against others and only when he realised that fighting others doesn't gain him anything, he changed his attitude. He suggested that if the teams were given different names, people would behave in a different way. However this is not the case, as it was demonstrated by the session described above.

3.4 Other Examples: "Crocodiles"

Another game which can be used in the same way as "Goats & Cabbages" is "Crocodiles". The participants are a group of explorers who were captured by a tribe of cannibals. They manage to escape, but unfortunately the cannibals have already "eaten" some parts of their bodies. Some people have lost one leg, some people, the tongue and some others, the eyes. The cannibals are still chasing them and, to make things even worse, the explorers have to overcome a serious obstacle: they arrive at the bank of a river, full of piranhas, which they have to cross. The only help they can count on comes from... crocodiles who allow them to cross the river by stepping on their backs.

This is the scenario of the game. At the beginning the participants choose by lot cards which represent their handicap in the game – the cards may represent, e.g., a crossed eye, a crossed leg or a crossed tongue. This way the roles in the game are distributed. Those who play the role of the blind cannot open the eyes during the game – the best solution is to bend their eyes, e.g., with a scarf; those who have lost their tongue are not allowed to speak and those who have lost their leg have to behave as if they really didn't have one leg – they have to jump on one leg till the end of the game.

When the roles have been distributed, the participants are shown the banks of the imaginary river. They are represented by two lines on the floor within a suitable distance from each other. On one of the banks, there are also some newspapers – these are the crocodiles. The participants can use them to cross safely the river. However they have to keep in mind that they can only step on the crocodiles – newspapers. If somebody touches the floor next to the newspaper with a hand or foot, it means that this person has fallen into the water full of piranhas. He or she has to come back to the bank of the river and start crossing it from the beginning. The newspapers cannot be placed on the river before participants start crossing it. They can only put the newspapers one by one while they move towards the other river bank.

The time for crossing the river is limited – if the explorers are too slow, they will fall into the hand of their pursuers. Before they start crossing the river, they are given a few minutes for choosing a strategy. It is important to say that the game starts when they begin to discuss on how to cross the river. It means that already during the discussion, "the blind" cannot open their eyes and "the mute" cannot speak!

The game was designed by German students as a play for children, which would help in the integration of the group. Nevertheless it can be also used with adults to discuss problems related to the concept of solidarity, cooperation, responsibility and the processes of communication. A part of the participants of the game have limited possibilities to communicate: some of them cannot speak and the others cannot see the signs given by "the mute". It is important to see what strategy was chosen by the participants. Was it based on cooperation or collaboration? Or maybe they behaved as individualists and egoists? The participants may also comment on how they felt in the role which was assigned to them. Was it very hard for them, e.g., not to be able to talk? Which role in their opinion was the most difficult one? Usually they agree that "the blind" were in the worst situation. People who play that role usually feel helpless and thrown at the mercy of the others. So this game opens a wide range of topics for further discussion, depending on the topic you are interested in.

4 Conclusion

The cases of the games "Goats & Cabbages" and "Crocodiles" show us how we can use games when we share the idea of knowledge that is constructed and the vision of learning as a creative process based on one's own discoveries. Even games which were created for other purposes, different from what we aim at, can teach us and make us understand the mechanisms which make part of our cognitive process: rules of cooperation, strategies, communication and leadership; the notions of scarcity, sustainability and renewability as well as political, economic or ideological differences.

> *We are developing a living science and not a dead doctrine* [...] *there is no bovine nor ovine gregariousness here*.
>
> (Charles S. Pierce, 1960

References

Asubel, D. P. (1963). *The psychology of meaningful verbal learning*. New York: Grune and Stratton.

Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. New York: Holt Rinehat and Wiston.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1986). *Educational psychology: A cognitive view*. New York: Warbel & Peck.

Duke, R. D. (1974). *Gaming: The future's language*. New York: SAGE.

Gowin, D. B. (1981). *Educating*. New York: Cornell University Press.

Myers, D. (1999). *Simulation as play: A semiotic analysis, simulation & gaming* (Vol 30, n.2). New York: Sage Publications.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn*. New York: Cambridge University Press.

Rizzi, P. (2003). Komunikacja miedzykulturalna a gry sysimulacyjne, Forum Europejskie, n. 3, Krakow.

Live-Action Role-Play or the Performance of Realities

B.O. Kamm and J. Becker

Abstract Live-action role-play (larp) has been named a “new performative art,” an immersive experience, and an educational tool, but it is much more: A playground of intermingling social and cultural realities, a door to new worlds. This paper offers an introduction to larp, its transcultural history, and its disruptive and creative possibilities, as well as key aspects, such as immersion. It sets the theoretical frame for the game “Staying Alive,” in which the researchers and also the audience engage in a shared “mimetic evocation of ‘real-life experience.’” Many aspects of “everydayness” can be called “collateral realities,” realities that are done implicitly, unintentionally, such as nations, cultures, time, or distinctions of subject and object, or of presenter and audience; realities that could be different. Taking performativity seriously, larp can be a tool to step outside of a Euro-American commonsense ontology and its singular reality “out there” by playing with collateral realities and making their production explicit. During a larp, players (“larpers”) consciously undo objects and meanings, space, and even their very bodies to creatively weave new material-semiotic fabrics. They become cultural mediators between a world-that-supposedly-just-is and its partially connected others, in which Japaneseness or Chineseness may fade and Elvishness is translated into a reality. With a global player base, larping is not only a practice of intersubjective or cultural negotiations but also of intra-subjective mediation of cultural realities.

Keywords Collateral realities • Cultural mediation • Larp • Live-action role-play • Performativity

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1 Introduction

> Right now, you are missing the vast majority of what is happening around you. You are missing the events unfolding in your body, in the distance, and right in front of you.
>
> By marshaling your attention to these words, helpfully framed in a distinct border of white, you are ignoring an unthinkably large amount of information that continues to bombard all of your senses: the hum of the fluorescent lights, the ambient noise in a large room, the places your chair presses against your legs or back, your tongue touching the roof of your mouth, the tension you are holding in your shoulders or jaw, the map of the cool and warm places on your body, the constant hum of traffic or a distant lawn-mower, the blurred view of your own shoulders and torso in your peripheral vision, [. . .].

This quote originates from *On Looking* (Horowitz 2014, p. 1), a study about the often-neglected visions and practices of the ordinary, by psychologist Alexandra Horowitz who also introduced us to a dog's perception of the world in her *Inside of a Dog* (Horowitz 2010). Both speak of different realities, their performances, realities often delegated to the sidelines. This paper also intends to look at such "collateral realities" (Law 2009) and their performance by focusing on how realities are created in so-called live-action role-plays (larps). In doing so, it focuses on the question of how such role-plays lend themselves as performance ethnographies and offers a theoretical framework for the larp "Staying Alive" (StA) scripted by the authors.

1.1 Basics: What Is Larp?

Larp, originally an abbreviation for live-action role-play, has moved on toward a word in itself in English and Scandinavian languages, so today it is usually written in lower case and used to label events ("larps"), and the activity, to larp or larping (Holter et al. 2009).

Still, larp remains a hard to define area of gaming because it overlaps with many everyday practices of role-playing and role-taking (cf. Goffman 1959) and other performance activities, for example, stage plays, vocational training, and therapy methods. By convention, larps count as one form of the genre *role-playing game* (RPG) because they share a number of aspects one also finds in tabletop and computer RPGs, such as *Dungeons & Dragons* or *World of Warcraft* (for a detailed discussion of dis-/similarities, see Hitchens and Drachen 2009). We call role-playing games an *assemblage of practices*, that is, a network of specific elements, such as bodily movements, material objects, and ideas, that is more or less stable in its connections so that others may speak about it. Each larp then amounts to a specific arrangement of these elements. The following are recognizable aspects of most practices called larping, but one will always encounter larps that eschew some elements, add others, or play with the idea of what a larp is itself. That is why we cannot offer a clear-cut definition but rather seek to highlight these characteristic features and show how larp as a practice flows across boundaries of play, performance, and the everyday.

Larps usually encompass the physical and interactive performance of fictitious characters in an imaginary world. In this sense, larps count as a form of role-playing because participants create characters with fictional but distinct personalities that are not just social roles, such as father or employer. These characters follow in their outlook specific parameters of the larp's setting or game world and are similarly the tools for the players to interactively define and redefine this game world (Montola 2003). In order to realize their settings, larps make use of costumes, props, architecture, and changes to the environment. In this regard, a larp may not differ much from a stage play production. Contrastingly, larps are not limited to a few hours on stage but evolve often over years of play. Thus, a fantasy game world may presuppose what Elves look like and how they behave, for example. Very much in-line with Judith Butler's idea of *performativity* (Butler 1990), however, the players realize these outlooks and behaviors through play, which may change over time how Elves are played and how the whole setting evolves. In this sense, larp settings are always cocreations of organizers and players.

Most larps are based on a combination of shared storytelling and certain elements associated with gaming. Larps usually have plots, predefined series of events, but mostly proceed through the improvised play of the participants. There are no pre-written scripts for players besides their characters' motivations and goals. In this sense, larps can be designated as a form of shared storytelling, storytelling often revolving around conflicts but not necessarily so. Most larps also include elements known from other forms of gaming, such as rules, obstacles and achievements (cf. Salen and Zimmerman 2003), and also character development, that is, increased knowledge or skills gained by the character (not the player) through being played in a larp. A common term for character growth in tabletop or computer RPGs is "leveling up." Depending on the rules used, a larp character's power might be similarly expressed in levels (character level or a particular skill level). An increasing number of larps eschew complex rule systems, though, and "limit" character capabilities to player capabilities. In a tabletop RPG a player would usually throw dices and check if his or her character succeeds at a given action, for example, moving silently (character's skill versus an opponent's hearing ability). In most larps, the player him- or herself would have to move silently with their own body. Such skills can only be improved by the player actually training them. Other skills, such as magical ability, improve in-game. During the two-day larp *College of Wizardry* (CoW; Raasted, Rollespilsfabrikken), participants play wizards and witches who continuously learn new spells in lessons of magic, which they then use outside of class (if they dare). Rules-wise, spell effects are not based on any form of power pool or reserve, such as magical points, but are instead limited by the fact that a spell can be used but once in a single combat and that the player on the receiving end determines the outcome.

By borrowing from other forms of role-playing games, larps are part of a network of sibling practices, which share some of the above elements and allow writing a transcultural history that may begin with war gaming in nineteenth century Prussia. Such a history would not amount to a direct tracing of development, however, but in most cases should be understood as an ex-post-assessment of similarities. Besides character development, larps share further aspects with tabletop role-playing, such as a distinction between game masters or referees and ordinary players or, content-wise, many borrowings from popular literature, like the sword and sorcery or science-fiction genres. While a tabletop game usually features only one game master controlling the setting and the supporting cast, a larp often needs a larger number of game masters and nonplayer characters depending on the size of the game (see Sect. 2 below).

Pretend play of children and Jacob L. Moreno's therapy methods for "normal people," the psychodrama (Moreno 1957), look in many ways like larps, too (Morton 2007). Concerning costuming and an at times extreme attention paid to realism or authenticity, we find not only similarities but also a shared population in the case of reenactment, for example, of the American Civil War in the USA or the battle of Dan-no-ura in Japan, as well as with the Society for Creative Anachronism (SCA). Model UN in many ways resembles larps as do alternate reality games (ARGs), but they also differ in how they are organized, how players are recruited, and how the "real" world is drawn into the game. *Cosplay*, the masquerading as a character taken from popular media, might look like a larp from the outside, but practitioners emphasize that larping and role-playing on the one hand are about becoming and playing a character of one's own creation, while cosplaying on the other focuses on recreating an existing character to be photographed (Kamm 2011). In Japan, for example, the populations of cosplayers and role-players rarely overlap.

Larp is increasingly coming of age in scholarly terms, including the establishment of a yearly conference on larp as well as an international peer-reviewed journal.[1] From within the emerging discipline of "role-playing and larp studies," the practice has been further defined in several ways. For example, Mackay calls it a "new performative art," similar to improvisational theater but also different as the distinction between performer and spectator is completely gone (Mackay 2001). Not all but some players take cues from the performing arts for their character portrayal, *method acting*, being one of the most prominent ideas gaining attention (cf. Constantin Stanislavski's "system" and Lee Strasberg's "The Method"). The scale of many larps, the freedom players enjoy, and the fact that players are always actor and audience at the same time are some of the aspects that set larp apart from other theatrical forms, which may warrant the label "new."

Many describe larping as an immersive experience, as a way of changing perspectives and becoming other (Larsson 2003; Harding 2007; Lappi 2007; Lukka 2014). The process of *immersion* is partly automatic and guided by individual predispositions to it. In immersed state the player feels in a pronounced way that he is the character in the game world. The result of immersion is a subjective experience where the sense of self and interpretative framework change (Harding

[1] *The International Journal of Role-Playing*, Utrecht School of the Arts, Utrecht, the Netherlands, established in 2009

2007, p. 25). Due to the detailed setups and other aspects of complete "make-believe," larping makes immersion understood in this form possible in a way no other media could, be it movies or computer games. It is a highly controversial concept discussed in larp studies so that there is no definition agreed upon by all larp scholars. Depending on the setting or aim of a larp, the possibility for immersion also differs (Holter 2007).

Concerning different kinds of settings, in principle, one can turn any topic, any genre, or any theme into a larp. Worldwide, the most common genre definitely is fantasy (Bölle 2013; Vanek 2015), often inspired by J.R.R. Tolkien's works, especially since the release of the movies directed by Peter Jackson. However, these genres are not exclusive: There can be fantasy larps with horror elements or any other mixture and crossover the organizers could think of.

Besides the general setting, larps are often categorized into different styles or types referring to what a given larp focuses on play-wise. Adventure cons, for example, include riddles, journeys, and often fighting or outright battles. Contrastingly, ambience cons focus more on character play and intrigue. But there are also games in which one group of players hunts for treasure and glory, while others concentrate on immersing themselves as thoroughly as possible into the fictional world and their characters. Mass cons with up to 7,000 players usually offer a broad range of possibilities matching most foci of interest. Most larps are *paratelic* activities (Apter 1991, p. 15), done for their own sake, and in this sense could be called entertainment. However, recently an increasing number of educators have rediscovered role-playing, and larpers have started to become school and college teachers, so that larps with a clearly educational agenda emerge. Any form of larp may encourage learning (effects); in some cases, one trains for a larp, for example, sword fighting or acting, but participants may also learn something that goes beyond the immediate larp experience. A larp set in WW2 or the Heian period of Japan (794–1185 C.E) may have the basic learning effect of conveying knowledge about these eras. The organizers of edu-larps on the other hand have an explicit teaching goal in mind, such as teaching children about nature during an adventure in a forest. Like any form of larp, educational larping can take place in a fantasy or sci-fi setting or in our contemporary society. Edu-larps usually target young players. Focusing on adults but very similarly aiming beyond the immediate larp experience are so-called avant-garde larps and pervasive larps that deal with self-awareness, political issues, and at times extreme experiences. Avant-garde larps are mostly associated with a "school" of larping known as Nordic larping, which also informed the scripting of "Staying Alive."

To summarize the above points, the practice larping can be pictured as a network of diverse elements, borrowed from gaming (especially, tabletop role-playing games, e.g., rules, spatiotemporal delimitation, obstacles and achievements, character development, and growth), science and pulp fiction (genres, world settings, etc.), theatrical performance and storytelling (e.g., acting in character, narrative plot, costuming, props), as well as educational or therapeutic role-playing (experiencing to be "other," acquiring skills and knowledge). The emphasis on these elements differs from event to event and player to player: Some larps are more simulational, focusing on in-character decisions, while others highlight shared storytelling, encouraging decisions based on drama, for example (cf. Bøckman 2003). Larps might be classified as games but on many levels are entangled with the lifeworlds of the participants: Costume preparation as one example suggests that most players also spend time and money on preparing for a larp. Nordic larps and the theories behind them, on the other hand, point to how larping not only references the everyday but may also have an effect on players "outside" the game. Despite the emphasis on learning effects of Nordic larping and edu-larps, they differ from "conventional" simulation and gaming (cf. Klabbers 2009) in this regard that designers and organizers do not seek to solve a particular problem posed by a specific client, such as in cases of urban planning or intra-corporate conflict resolution.

1.2 Nordic Larp

This school or community of larpwrights (designers) developed around the annual Scandinavian larp conference, *Knudepunkt*, and is thus usually referred to as "Nordic larp," although such larps are recently organized almost anywhere in the world, from Brazil to Poland (Stenros 2014).

Nordic larp cannot be defined content- or genre-wise but more by the demand to be political, the aim to go beyond established limits, and an explicit artistic vision. Most games feature the ideals of *complete immersion* and a "360-degree illusion," so that the scenography uses as little as possible symbolic props to not push players out of their character and enable "persistent role-playing." Players are asked to stay in character for the complete duration of a game, different to US "theater-style" larps, which usually have many players switching constantly between their fictional and their "real" selves. Nordic larps are also usually considerably physical: "Amorous and antagonistic encounters, and everything in between, are played as is – at least up to a point" (Stenros 2014, p. 150).

While immersion is an intra-subjective ideal, most Nordic larping also favors cooperation and cocreation and less competitive aims to win the game or battle (Stenros 2014).[2] Following a political or artistic agenda, Nordic larps explore a thematic topic or a particular emotion: "[They] tend to be about something, be it love, the war in Afghanistan or the loss of humanity. Usually the ideal is to craft the larp in a way that makes the theme relevant for all participants" (Stenros 2014, p. 151). In order to ensure this relevance, Nordic larps are usually noncommercial and include pre- and post-event workshops (cf. the necessity of extended debriefing, Auchter and Kriz 2014), which sometimes take longer than the actual larp, especially if their topic is about an extreme experience, such as imprisonment in a fascist

[2] Even though strictly speaking, also most larps outside the sphere of "Nordic larp" are not about winning per se.

regime, or about recreating the living conditions of a people suppressed by another military state. What these larps aim at doing is playing with things taken for granted, with "collateral realities."

Claus Raasted, a figurehead of the Nordic larp community, started to organize *College of Wizardry* in 2014 and is running this wizard school larp four times a year at Czocha Castle, Poland, with about 130 participants each time. Its theme is less overtly political but aims at cocreation, drama, and exchange. For example, questioning the idea that games are about winning, participants are asked to play to lose: "We want drama, escalation of conflicts and de-escalation back to normalcy again. We want intrigues and friendships. And most of all, we want to make sure that all players know that here it's more fun playing to lose – you'll get better drama and awesome scenes."[3] As CoW draws participants from all over the world, play experiences and expectations also differ widely. Instead of trying to overcome these differences by force and squeezing them into a tight rules system, CoW seeks to celebrate them. For this purpose, the organizers offer the "typical" workshops before play commences. Because CoW is a prime example of current larping, we will continue to refer to this larp throughout this paper and also juxtapose it with the larp scripted by the authors.

1.3 "Staying Alive"

In the spirit of Nordic larping and with the aim to introduce larps as a tool for research presentation to the academic discourse, the authors scripted an "academic larp" to showcase the possibilities of using the performative aspects of this practice. In the following sections, we draw on this 90-min larp and the feedback we received from the participants to make clear how larps can create alternate realities while still playing with the everyday.

"Staying Alive" (StA) is planned as a Kafkaesque drama about a commission's questioning and judging of ordinary citizens on their worth for human society. Inspired by "A Mother's Heart" (Christensen and Fatland 2013), a larp about judging the performance of mothers in Norwegian society, the authors scripted StA for academic purposes of raising awareness on environmental issues and the matter of judging people. StA takes place in a hearing room setting with inquisitors, aspirants, and an unlimited number of people acting as members of the commission. Because this commission consists of a participating audience, the game allows players to take on a more observant role and thus experience the larp as an introduction for non-larpers/spectators.

During play, the participants produce a wide range of "collateral realities," which become the topic of discussion for the subsequent debriefing of the participants. This larp seeks to question our societal systems, social interactions, and the

[3] CoW Event Info, www.cowlarp.com/#!about/c10fk (retrieved 2015/06/15)

consequences of expressing random judgments. It further offers participants to experience *immersion* firsthand.

2 Larp Operations

Before venturing into the territory of "collateral realities" and their role in StA, let us briefly review how larps work. The following overview, however, does not cover practical aspects comprehensively, such as the logistical and event management part of any, especially, larger larps.

Larps hinge on two interwoven frameworks. The first is a diegetic framework that consists of the setting, the characters, and usually, not always, a plot. Settings range from themes, such as that all players are spies, to narrative or historical backgrounds of complete otherworlds, comparable to the worlds of middle-earth or Westeros. The diegetic framework or setting for *College of Wizardry*, for example, is a remote castle that houses a wizard school very much like the famous Hogwarts of the *Harry Potter* series (even though the organizers, after two initial runs, emphasize that their game is not a "Harry Potter larp" and do not use any special vocabulary taken from the series). This framework presupposes students of various levels, teachers, rival fraternities/houses, and, of course, magic. The setting of "Staying Alive," on the other hand, is more or less equivalent to contemporary Earth, just a bit more than 200 years in the future:

> It is the year 2234: Over two hundred years have passed since the Antarctic ice began to melt beyond the point of no return. Sea levels have risen, countries have vanished, and societies have changed.
>
> The 'Protectorate of Ararat-Matsya' is one of the few remaining state-like entities, providing protected and dry living space for its citizens. Protectorates are no nation-states but have a more corporation-like character, which in a sense allows for the hiring and firing of citizens.
>
> With an increasing population and ever-receding coastlines, however, this space shrinks each day. The government and ruling corporations have created gated estates in the mountains for 'privileged citizens' – those who are an asset to society. This makes rigorous citizen evaluation necessary.
>
> This larp is about such evaluations of people.

Characters in a larp interlink with such a setting – so StA does not feature Elves but limits the cast to humans, for example; CoW also allows only "human" witches and wizards as player characters. These characters can be based on brief sketches or concepts or on dozens of pages of character background, motives, and personality traits and align with these settings.[4] A larp can just proceed from the interaction of such character motives, but many larger events rely on something called a "plotbook," which covers a schedule for certain events to happen during the larp,

[4] For an example of setting and linked character descriptions, see the play reference of StA: www.b-ok.de/download/larp/kamm_becker_StA2015.pdf.

tasks for specific characters, and so on. This is like a running schedule combined with a bare-bones movie script, bare bones because much is left open for improvised, unpredictable play. In CoW the major scheduling device is the lesson plan, which organizes the 2 days and three nights of play into several teaching sessions but leaves space for free time, during which interplayer intrigues may unfold as well as events scripted by the organizers. Besides, students can, of course, skip classes, if they can deal with the consequences.

StA, again, is based on several sequences of a hearing: First, a character named Master of Procedure leads the Aspirants – ordinary citizens accused of being no asset to society – into the hearing room. There are up to four Inquisitors already awaiting the Aspirants, and during the hearing each speaks for a couple of minutes to convince the commission that the Aspirants do not and never will contribute to society. After the Aspirants have defended themselves, they are led out of the room and judged in absence by the commission. While the Master's task is to ensure timekeeping and order, the Inquisitors shall accuse and the Aspirants shall reply, everything that happens during the larp is up to the players. They may follow the rules or disrupt the hearing as they see fit (or how they envision their characters would do).

The second framework is more of a structural kind. Participants are usually divided along a certain form of organizational hierarchy. Most participants are players, who create or cocreate and play their own characters. Not all larps have them, but another category is called nonplayer characters (NPCs). "Normal" players who receive instructions and assignments from the larp's organizers embody these NPCs. Such assignments may be one-shots, such as to walk down a street and yell, or can be major roles, antagonists or helpers. Since the Inquisitors in StA receive instructions on how to see the play world, i.e., what to value and what to condemn in the Aspirants (see Fig. 1), they could be considered NPCs. However, the players are still relatively free in their performance of the Inquisitors and allowed to change the prescribed attitudes during the game, so they could equally be seen as player characters with a little extra information. The same is true for the teachers in CoW who have to come up with lessons in various subjects but are otherwise free to experience the game. Larpwrights, organizers, and game masters usually stay in the background, writing the plot or administering the rules during play. As stated above, some larps have only few rules, so that characters can do whatever their players can do. Others make use of elaborate rule systems to judge if a character can do something, be it opening locks or casting spells.

The rules are interwoven with the setting in the sense, for example, that a larp set in our world usually does not need rules for magic or that a classical fantasy game does not allow for computers and thus does not have a "computer skill" players can choose for their characters. CoW and StA mostly incorporate "societal" rules only based on the setting and the roles of the characters.

Larps produce stories or narratives through experience. In narratology this link has been termed *experientiality* (Fludernik 1996), referring to an understanding of narratives as representations of experience. During the process of creation and/or storytelling, author and reader make use of acquired knowledge by conveying their

INQUISITOR Job description

1. Your job is to prove that the Aspirants are bad citizens.
2. During a Hearing, each Inquisitor will perform their Interrogation in turn.
3. Each Interrogation lasts no more than 2 minutes per Aspirant (4 minutes in total). This might take any form you want, like cross - examination of the Aspirants, an accusatory speech, etc.
4. On your desk is information about each of the Aspirant. This is the written character of the Aspirant, so you have the same information as his/her player. Pretend you acquired this knowledge some other way - e.g. "an informer told me..." "it is written in your case file that..."
5. Feel free to invent further points of accusation against the Aspirant.

You have four main abilities:

- You may improvise or invent further points of accusation during the game. Things you improvise are true by definition (e.g. if you ask the Aspirant why she was at Whole Foods yesterday, then she WAS at Whole Foods yesterday, even if her player did not know this before you asked).
- You decide what the Law says. You can invent laws that the Aspirant has broken.
- If you have a Specialist Card, you can call a Specialist. Give the card to the Master at the beginning of your turn. The Specialist will be called after your accusation.
- If you ask the commission: "is the Aspirant adequate?" they will answer "No." if you ask "Is the accusation correct?" they will answer "Yes." You should do this at least once during your interrogation to pressurize the Aspirant.

Fig. 1 Excerpt from a character description for "Staying Alive"

own embodied and emotional appraisal of temporally unfolding actions to actually experience a story and trigger immersion. Concerning this criterion, the narrative quality of larps is clearly discernable: Players retell their experiences and relate actions to past encounters, sensory impressions, and cognitive stimuli from their "real" lives. In this sense, experientiality refers to quasi-mimetic evocations of real-life experience.

During a larp, however, we can cross out the "quasi," the "as if." The creation of a shared narrative similarly works with an activation of cognitive parameters, such as an understanding of intentional action, the perception of temporality, and the emotional evaluation of experiences. Players might cognitively mimic real-life situations, but they do not merely read or tell about them, they actually create and experience them. In addition, the role-taking in larps not only provides a means for immersion but the character also enables another level of experientiality. Through the possibility (and the obligation) to embody an element of the narrative, past and present experience of a player merge and become a momentum in several realities during a larp. Whereas player and character remain separate entities, they share experiences and a position within the narrative: "[E]very character played by an actor is the main character of their own story" (Simkins 2015, p. 11). Not only cognitive processes brought about through shared experiences unite the two agents but their shared reality within a narrative. Similarly, larpwrights prepare situations, encounters, and NPCs that feel "real" in the sense that players can relate to past real-life or larp experiences when evaluating these encounters or characters. So the intentions of NPCs and their behavior, for example, must be comprehensible, plausible, and consistent with the setting and earlier events. If these characters and their behavior do not match these criteria, players are less likely to act out and embody their own characters; they are less inclined to step into the "magic circle" of a larp.

The term "magic circle" derives from the work of Johan Huizinga (1971) and designates the spatial and temporal separation of play from other activities. For example, a football game is clearly delimited by a 68×105 m playfield and a duration of two times 45 min. Chess is defined by its board and so on. "Magic circle" refers to this practical but also analytical separation (Salen and Zimmerman 2003; Montola 2012). For larps, this separation is operationalized in many different ways, be it through the costumes, the prepared environment, or a *suspension of disbelief* (Böcking et al. 2005) but fore and foremost through the displacement of "realities."

Larps usually differentiate during play between off-game and in-game. In-game refers to the plot and character play, off-game to logistical aspects but also to emergencies. For example, in larps safety words are employed that immediately stop the gameplay of everyone present until the emergency, such as a real wound, is resolved. Such safety regulations are CoW's only "hard" rules (Raasted 2015, p. 41). Contrastingly, one may also encounter so-called "off-game bubbles," that is, groups of players who do not stay in character and chat about a recent football match or their newest smartphone.

StA relies on the advantage of a closed environment, the hearing room, to create its "magic circle." In this practical sense, "magic circle" refers to the arrangement of materials and player performance that allows players to shift "realities" and stay in-game. This is again an issue of immersion. There are ways to make immersion easier, one of which may be called, for lack of a better word, realism, and connects to the aforementioned experientiality. "Staying Alive," for example, makes use of door signs (with an "official" logo) to protect the hearing room from outside interference (see Fig. 2). These door signs apparently had the power to keep even high-ranking professors from entering when they came late to a game session, as the authors were told afterward. Name tags further helped the participants to quickly understand the hierarchy of Master, Inquisitors and Aspirants – the latter, for example, received only name tags with numbers and were thus not addressed by their (fictional) names, increasing the distance between accusers and accused. The strict and grim performance by Master and Inquisitors during a session at Heidelberg University created an atmosphere in which other participants actually feared the consequences of interrupting the hearing or protesting its judgmental setting.

Authenticity and realism in larps receive a remarkable twist, however, when we see that these terms are applied to Elven behavior or the outfit of a starship captain. So not only plot and characters play their part, also props and other equipment. This is what the ideal of 360 ° larp aims at realizing: "[T]o place the players in a physically total, real and present environment, while refusing to limit itself to realism in genre or subject matter" (Koljonen 2007, p. 175). Though there are many difficulties in achieving such a distraction-free environment – just knowing the other players from another context or before the game may break the illusion – it remains an ideal to facilitate immersion into the game world. Tools for this include a space that is limited (and thus manageable, the experiences there more or less

Fig. 2 StA props: verdict forms, door sign, and name tent card

controllable) with clear defined borders that, however, appear permeable to the players: The best example is a boat (cf. Koljonen 2007), which is a limited space but keeps the possibility of people leaving it – another one can be a conference room turned into a hearing.

3 "Academic" Larps

Edu-larp and Nordic larp are two applications of larp which play with the "magic circle" of gaming, that is, the analytical separation of playing and not playing, or "serious life," short for work and reproduction. In this sense, larping provides an opportunity also for the academic context to convey research findings or raise awareness in a similar way "performance ethnography" does. Performance ethnographies are collaborations between researchers and those under study, aiming at multivocality and revolving around audience participation (Denzin 2003). The ethics behind this mode of research presentation tries to overcome issues of representation, such as those of a privileged researcher speaking for another group.

Through a shared performance, the audience is more or less directly involved. Such ethnographies follow a number of performative criteria: They want to unsettle, criticize, and challenge taken-for-granted, repressed meanings, engender resistance, and offer utopian thoughts about how things can be made different (Denzin 2003, p. 123).

Nordic larp follows similar principles. As a general statement one could say that such larps are also not about telling, which is a common mode of scholarly communication, but about showing, or to be more precise, they are about experiencing. In this way they differ from performance ethnography, as there is no audience left, everyone participates.

From a philosophically inclined perspective, larping was interpreted as a playground of intermingling social and cultural realities, a tool for exposing, to make visible hinterlands and things taken for granted, to experience life worlds different from ones' own, such as nuclear war, homelessness, or different cultural settings (Montola and Stenros 2008, p. 5). Whether larps are entertainment, ontological laboratories, or attempts to subvert the ordinary, they employ and deploy alternative realities.

The idea of alternative realities can be seen in a sense as a reformulation of the distinction between playing and "real life" inherent to the concept of the "magic circle" as a ludologically necessary differentiation. Ludological here means that the distinction is an analytical one. In this view, our social reality is full of all kinds of layered meanings, and play and gaming are based on adding additional layers. Thus, when game scholars contrast play with "ordinary life," it should not to be read as meaning that there are only two types of activity in human life and that game scholars study one half of it. Rather, "ordinary life" is shorthand for all cultural contexts that are not flagged as playful (Montola 2012). In short, for the study of games, "magic circle" and "ordinary life" are not statements about the ontological constitution of the world but abbreviations for complex phenomena of "social construction." Montola and other larp scholars explicitly position themselves within the tradition of "weak social constructionism," following John R. Searle (1989), and to some degree philosopher of science Ian Hacking (1999), stating that "material reality exists independently of mankind, but it is meaningless without consciousness" (Montola 2012, p. 19). This is by and large equitable with multiculturalism/mono-naturalism or "perspectivalism," that is, the "Western" ontology of one real world out there and the different cultural views about this one world (Law 2009, p. 1). In this sense, larp adds another "cultural" view.

4 Larp *Does* Realities

In our application of larping, we want to go beyond "perspectivalism." Larp as a practice does realities much the same way other practices do and thus might work as a tool to make the many "collateral realities," usually taken for granted, visible.

Many aspects of "everydayness" can be called *collateral realities*, realities that are done implicitly, unintentionally, such as nations, cultures, genders, time, or distinctions of subject and object and of presenter and audience – realities that could be different (Law 2009). Reality here refers to dynamic arrangements and connections built from material and semiotic elements through practices. Studying *collateral realities* means the tracing of practices, in which these realities are produced, such as statistical data organized along the category of nation, ticking off a box asking "male" or "female," or using PowerPoint and videos to show some things and hide others.

Taking practices and thus performativity seriously, larp can be a tool to step outside of a Euro-American commonsense ontology and its singular, coherent reality "out there" by playing with *collateral realities* and making their production explicit. During a larp, players consciously undo objects and meanings, space, and even their very bodies to creatively weave new material-semiotic fabrics. They become cultural mediators between a world-that-supposedly-just-is and its *partially connected* others (Strathern 2004), in which Japaneseness or Chineseness may fade and Elvishness is translated into a reality. This is exactly what a few exchange students from Japan and China (observed by the authors) experienced when they participated in a larp organized by a youth association in Bavaria, Germany. Here, Chinese became a mystical language of prayer used to fight off sinister, otherworldly creatures.

With a global player base, larping is a practice of intersubjective or cultural negotiations but not only that. Larping can also become an *intra*-subjective mediation of cultural realities, such as between ones' own everyday and that of strangers. This transcultural mediation, when boundaries are made and unmade, is called "bleed" in larp speak.

Larp designers play with and rely on spillovers between players and their characters. Cognitive and emotional spillovers are referred to as *bleed* in larp or RPG theory (Pettersson 2014). One direction bleed can take is from the character or from the game to the player, an effect specifically aimed at in educational larps or serious games, fore and foremost in many pervasive forms of role-playing. *Projekt Prometheus* (Springenberg and Steinbach 2010) aimed at teaching players about political conspiracies and stereotypes. Frederik Østergaard's *Fat Man Down* wanted to raise awareness about how badly we treat overweight people in our society – but may only show how miserable fat people feel (Pettersson 2011).

Even though it aims at "outside" results, bleed here is very much in-line with immersion as the goal is to involve players in the topics of the games emotionally so that they carry insights with them to the "real world." This form of bleed is imagined to flow from character to player and thrives on "realism," that is believable and possibly "complete" settings, probable characters, and narratives. A game that resembles the everyday more closely is seen as offering advantages over those that do not.

Other games make use of the opposite direction of bleed. Especially horror-oriented games try less to scare the characters and more the players themselves, which rests on the experience that a scared player enacts a scared character. The techniques employed for such endeavors are usually borrowed from other media, be it film or theater.

Following these ideas of how societal issues or cultural negotiations can be made into an experience, we scripted the larp "Staying Alive" and held play sessions with academics in 2014 (Heidelberg) and 2015 (Kyoto). In the spirit of Nordic larping, these play sessions culminated in a debriefing during which the participants could voice their thoughts about the experience.

5 Debriefing "Staying Alive"

Before playing "Staying Alive," all participants in Heidelberg voiced skepticism toward the concept of immersion and the possibility of a larp changing their frame of reference. During the debriefing, immersion and the displacement of "realities" remained in the focus so that the feedback revolved less around the environmental issues hinted at through StA's setting.

Especially, those participants who took up major roles (Inquisitors, Aspirants) spoke of their surprise about how quickly they were immersed in their characters, feeling either mighty or extremely trapped. One Inquisitor indicated how he soon stopped thinking about what his character would or should do but just let his tongue have a go after "settling" into the brief description of the character's goals given by the organizers. The submissive behavior of one Aspirant player added to his own sense of superiority so that their interaction cocreated a spiral of accusation and defense. The strict timekeeping added to the tension and allowed each player only a few minutes to voice his or her thoughts. Next to the nametags or door signs, the time keeping emerged as another device playing with "collateral realities:" that a hearing necessarily restricts speaking time, that time is money, and that keeping time is more important than listening to a human defending his or her way of life. None of the players questioned such a procedure, showing how "natural" the value of time is in our everyday.

In Kyoto, the feedback was of a different kind: All participants were game and simulation designers themselves and thus had difficulty in leaving an analytical frame of mind while trying to understand how a larp works. Thus, they experienced more pressure to live up to the task of character portrayal set before them instead of the pressure to defend their life as the characters. Here, the "collateral reality" produced can be seen as one of a "professional" kind, to be faithful to the rules of the game, such as that Inquisitors have to *prove* that the Aspirants are bad citizens, which led to rather harsh accusations.

In general, those participants who had a mostly observant role (the commission) experienced less or no immersion and involvement. However, also one member of the commission in Heidelberg, for example, reported fear and the rush of adrenaline when she wrote "Down with the System!" on her verdict form instead of checking one of the preset judgments. The other participants around her would have eyed her suspiciously, and she was sure she would have been reported if the play session did not have to end after the given 90 min. Again, the power of time appears as a "collateral reality."

As an introductory larp, StA not only allowed players to take the roles of Inquisitor or Aspirant but give a little life to characters with names, worldview, goals, and emotions, for which they all drew from their own past experiences (e.g., a literature professor could turn critique voiced against his profession into accusations against the Aspirant who was scripted as a literary scholar) – at least to a certain degree. This form of "bleed" intermingled with the other elements of the larp to briefly create a new "reality," which functioned for 90 min (without the guidance of a game master or the necessity to solve issues off-game, that is, from outside the "magic circle") through the players' inter- and intra-subjective interaction with the parameters of the setting and the "collateral realities" the larp played with. In lieu of a conclusion but as a final highlighting of characteristic features, the cocreative mixing of known and imagined realities can be deemed *the* cornerstone of larping.

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References

Apter, M. J. (1991). A structural-phenomenology of play. In M. J. Apter & J. H. Kerr (Eds.), *Adult play: A reversal theory approach* (pp. 13–29). Amsterdam: Swets & Zeitlinger.

Auchter, E., & Kriz, W. C. (2014). The impact of business simulations as a teaching method on entrepreneurial competencies and motivation – a review of 10 years of evaluation research in entrepreneurship education. In W. C. Kriz, T. Eiselen, & W. Manahl (Eds.), *The shift from teaching to learning: Individual, collective and organizational learning through gaming simulation* (pp. 55–65). Dornbirn: ISAGA.

Böcking, S., Wirth, W., & Risch, C. (2005). Suspension of Disbelief: Historie und Konzeptualisierung für die Kommunikationswissenschaft. In V. Gehrau, H. Bilandzic, & J. Woelke (Eds.), *Rezeptionsstrategien und Rezeptionsmodalitäten* (pp. 39–57). München: Fischer.

Bøckman, P. (2003). The three way model. Revision of the threefold model. In M. Gade, L. Thorup, & M. Sander (Eds.), *As larp grows up – theory and methods in larp* (pp. 12–16). Copenhagen: BookPartner.

Bölle, J. (2013). *LARP-Statistik Deutschland 2013*. Retrieved from http://www.section32.de/fantasy/statistik2013/

Butler, J. (1990). *Gender trouble*. New York: Routledge.

Christensen, C., & Fatland, E. (2013). A mother's heart. In E. Nilsen, L. Stark, T. L. Lindahl, & A. M. Stamnestrø (Eds.), *Larps from the factory* (pp. 25–29). Copenhagen: Rollespilsakademiet.

Denzin, N. K. (2003). *Performance ethnography: Critical pedagogy and the politics of culture*. Thousand Oaks: Sage.

Fludernik, M. (1996). *Towards a "natural" narratology*. London/New York: Routledge.

Goffman, E. (1959). *The presentation of self in everyday life*. New York: Anchor.

Hacking, I. (1999). *The social construction of what?* Cambridge: Harvard University Press.

Harding, T. (2007). Immersion revisited: Role-playing as interpretation and narrative. In J. Donnis, L. Thorup, & M. Gade (Eds.), *Lifelike* (pp. 25–34). Copenhagen: BookPartner.

Hitchens, M., & Drachen, A. (2009). The many faces of role-playing games. *International Journal of Role-Playing, 1*(1), 3–21.

Holter, M. (2007). Stop saying immersion. In J. Donnis, L. Thorup, & M. Gade (Eds.), *Lifelike* (pp. 18–22). Copenhagen: BookPartner.

Holter, M., Fatland, E., & Tømte, E. (2009). Introduction. In M. Holter, E. Fatland, & E. Tømte (Eds.), *Larp, the universe and everything* (pp. 1–8). Haraldvangen: Knutepunkt.

Horowitz, A. (2010). *Inside of a dog: What dogs see, smell, and know*. New York: Scribner.

Horowitz, A. (2014). *On looking: A walker's guide to the art of observation*. New York: Scribner.

Huizinga, J. (1971). *Homo Ludens: A study of the play-element in culture*. Boston: Beacon.

Kamm, B.-O. (2011). Why Japan does not larp. In T. D. Henriksen, C. Bierlich, K. F. Hansen, & V. Kølle (Eds.), *Think larp. Academic writings from KP2011* (pp. 52–69). Koppenhagen: Rollespilsakademiet.

Klabbers, J. H. G. (2009). *The magic circle: Principles of gaming & simulation: Third and revised edition*. Rotterdam: Sense Publishers.

Koljonen, J. (2007). Eye-witness to the illusion: An essay on the impossibility of 360° role-playing. In J. Donnis, M. Gade, & L. Thorup (Eds.), *Lifelike* (pp. 175–187). Copenhagen: BookPartner.

Lappi, A.-P. (2007). Playing beyond facts: Immersion as a transformation of everydayness. In J. Donnis, L. Thorup, & M. Gade (Eds.), *Lifelike* (pp. 75–82). Copenhagen: BookPartner.

Larsson, E. (2003). Postmodernism. In M. Gade, L. Thorup, & M. Sander (Eds.), *As larp grows up: The lost chapters – more theory and method in larp* (pp. 10–14). Frederiksberg: Projektgruppen KP03.

Law, J. (2009). Collateral realities. In *Heterogeneities*. Retrieved from http://www.heterogeneities.net/publications/Law2009CollateralRealities.pdf

Lukka, L. (2014). The psychology of immersion. In J. Back (Ed.), *The cutting edge of nordic larp* (pp. 81–92). Gråsten: Knutpunkt.

Mackay, D. (2001). *The fantasy role-playing game: A new performing art*. MacFarland: Jefferson.

Montola, M. (2003). Role-playing as interactive construction of subjective diegeses. In M. Gade, L. Thorup, & M. Sander (Eds.), *As larp grows up – theory and methods in larp* (pp. 82–89). Copenhagen: BookPartner.

Montola, M. (2012). *On the edge of the magic circle. Understanding role playing and pervasive games* (Doctoral dissertation). University of Tampere.

Montola, M., & Stenros, J. (2008). Introduction. In M. Montola & J. Stenros (Eds.), *Playground worlds: Creating and evaluating experiences of role-playing games* (pp. 5–10). Helsinki: Ropecon ry.

Moreno, J. L. (1957). *The first book on group psychotherapy*. New York: Beacon House.

Morton, B. (2007). Larps and their cousins through the ages. In J. Donnis, M. Gade, & L. Thorup (Eds.), *Lifelike* (pp. 245–259). Copenhagen: BookPartner.

Pettersson, J. (2011). Take responsibility – or: "Don't hide behind pretentiousness". In C. Raasted (Ed.), *Talk larp – provocative writings from KP2011* (pp. 53–59). Koppenhagen: Rollespilsakademiet.

Pettersson, J. (2014). Larp for change: Creating play for real world impact. In J. Back (Ed.), *The cutting edge of nordic larp* (pp. 71–80). Gråsten: Knutpunkt.

Raasted, C. (2015). *College of wizardry design document*. Retrieved from http://www.rollespilsfabrikken.dk/cow/dd/designdocument.pdf

Salen, K., & Zimmerman, E. (2003). *Rules of play: Game design fundamentals*. Cambridge: The MIT Press.

Searle, J. R. (1989). How performatives work. *Linguistics and Philosophy, 12*(5), 535–558.

Simkins, D. (2015). *The arts of larp: Design, literacy, learning and community in live-action role play*. McFarland: Jefferson.

Springenberg, D., & Steinbach, D. (2010). Projekt Prometheus – alternate reality games in civic education. In E. Larsson (Ed.), *Playing reality* (pp. 109–120). Stockholm: Interacting Arts.

Stenros, J. (2014). What does "Nordic Larp" mean? In J. Back (Ed.), *The cutting edge of nordic larp* (pp. 147–156). Gråsten: Knutpunkt.

Strathern, M. (2004). *Partial connections*. Walnut Creek: AltaMira Press.

Vanek, A. (2015). *Revelations of the larp census*. Talk presented at the Knudepunkt 2015, Ringe, Denmark.

Participants' Perceptions of Gaming Simulation

Mieko Nakamura

Abstract This paper reports participants' perceptions of gaming simulations (g/s) before and after a 15-week course, using a semantic differential method to analyze two groups of students. From 2011 to 2013, approximately 600 students were asked to rate their perception of g/s on a five-point scale. While the two groups showed similar tendencies, one group showed a clearer attitude than the other. A noteworthy result was the groups' changed perception of g/s from simple to complex after the course. The results of factor analyses showed two possibilities: the "complexity" factor changed from negative to positive while the "challenge" factor needed to be obtained. Differences in students' readiness for g/s were discussed.

Keywords Participants' perception • Gaming simulation • Semantic differential method • Exploratory factor analysis • "Flow" theory

1 Introduction

I regularly facilitate gaming simulations (g/s) in two freshmen courses in two Japanese universities: a "decision making" course and a "society and human beings" course. Most students have had little experience of g/s in academic life and while some participate willingly, others are suspicious of its regular use.

The purpose of this paper is to characterize students' perceptions of g/s and the changes in this perception over a 15-week course. In addition, the differences between two groups of students are examined. The concern here is to grasp current perceptions of g/s and consider its future direction for use with students.

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2 Course Outline with Gaming Simulation

Both courses shared 75 % of topics in common ("communication," "leadership," and "social dilemmas") while 25 % were specific to each course ("optimal production technology" for the "decision making" course and "information sharing" for the "society and human beings" course). The style of teaching is almost identical in both courses. The courses comprised 15 classes, during which several g/s were conducted as follows: three classes were scheduled as a unit, apart from the first class (introduction), the eighth class (midterm exam), and the final class (term-end exam). In a typical unit, the first and second classes were used to run games and the third for debriefing. The actual process was as follows: students were randomly divided into groups and instructed to work together as a team. In each of the two gaming classes, instruction papers were distributed and oral explanations were given with a large-screen display. The groups worked in parallel and after completion of their work, participants filled out a debriefing form and shared opinions within the group. The students took these forms home to prepare reports for the third-class debriefing session. In the third class, students orally presented their reports about the two gaming sessions and/or silently read five to ten fellow-student reports. This debriefing session also included a mini-lecture by the teacher and group discussion. In each class, students worked with different members in different groups.

3 Questionnaire with Semantic Differential Method

Dozens of words related to g/s were collected from those who had played several different kinds of g/s, and 15 pairs of words were selected and shaped into the semantic differential method (Nakamura 2014): (1) bright-dark, (2) soft-hard, (3) -hot-cold, (4) active-inactive, (5) loud-quiet, (6) serious-unserious, (7) rational-emotional, (8) close-far, (9) tough-enjoyable, (10) difficult-easy, (11) free-bound, (12) complicated-simple, (13) intensive-mild, (14) deep-shallow, and (15) -interesting-uninteresting. Participants were asked to rate their perception of g/s on a five-point semantic differential scale: "very," "to some extent," "neither," "to some extent," and "very." For the purposes of calculation, these were located on a line segment at equal intervals and then converted to values from 1 to 5, respectively.

very   to some extent   neither   to some extent   very
bright I – – – – – I – – – – – – I – – – – – – I – – – – – – I dark

From 2011 to 2013, 12 groups of students took the courses and in each case the questionnaire was distributed twice, at the beginning and end of the course. Henceforth, Group A denotes participants in the "decision making" course and

Group B participants in the "society and human beings" course. The number of participants approximated 600 in total. Data with missing values were excluded and 331 data items were analyzed for Group A and 248 for Group B.

4 Questionnaire Results

Table 1 shows Group A's means in the pre- and post-surveys and the results of the *t*-test. Figure 1 shows a diagram of the respective means in Table 1, arranged in pre-survey ascending order. As shown in Table 1 and Fig. 1, the four lowest mean scores in the pre-survey were for Q1 bright-dark, Q4 active-inactive, Q15 interesting-uninteresting, and Q11 free-bound. That is, respondents perceived g/s as bright, active, interesting, and free. This perception slightly changed in the post-survey; respondents perceived g/s as more interesting and less free. On the other hand, the three highest mean scores in the pre-survey were for Q9 tough-enjoyable, Q12 complicated-simple, and Q10 difficult-easy, all beyond the midpoint of the scale (3). Therefore, respondents initially perceived g/s as enjoyable, simple, and easy. At the end of the course, the highest mean score was recorded for Q9 tough-enjoyable. Respondents continued to perceive g/s as enjoyable but no longer perceived it as simple as before. Eight items differed significantly between the pre- and post-surveys as shown in Table 1: Q3, Q5, Q7, Q11, Q12, Q13, Q14, and Q15. Of note is that g/s was conceived as simple at the beginning of the course and complicated at the end.

Table 1 Group A's means in the pre- and post-surveys and the results of the *t*-test

	Pre-survey's mean(SD)	Post-survey's mean (SD)	t-value
Q1 bright-dark	1.79 (0.67)	1.74 (0.70)	0.95
Q2 soft-hard	2.19 (0.72)	2.19 (0.86)	0.06
Q3 hot-cold	2.42 (0.76)	2.25 (0.86)	3.19**
Q4 active-inactive	1.87 (0.88)	1.82 (0.74)	0.73
Q5 loud-quiet	2.50 (0.85)	2.20 (0.90)	5.00**
Q6 serious-unserious	2.68 (0.79)	2.60 (0.88)	1.45
Q7 rational-emotional	2.98 (0.87)	2.68 (0.98)	4.51**
Q8 close-far	2.42 (0.79)	2.38 (0.87)	0.61
Q9 tough-enjoyable	3.82 (0.94)	3.80 (1.02)	0.23
Q10 difficult-easy	3.13 (0.99)	3.03 (1.05)	1.40
Q11 free-bound	1.91 (0.79)	2.02 (0.85)	2.02*
Q12 complicated-simple	3.21 (1.01)	2.69 (0.98)	7.46**
Q13 intensive-mild	2.90 (0.99)	2.70 (0.98)	2.88**
Q14 deep-shallow	2.37 (0.96)	2.01 (0.98)	5.39**
Q15 interesting-uninteresting	1.88 (0.83)	1.64 (0.81)	4.51**

The number of respondents is 331
SD Standard deviation
*$p < 0.05$; **$p < 0.01$

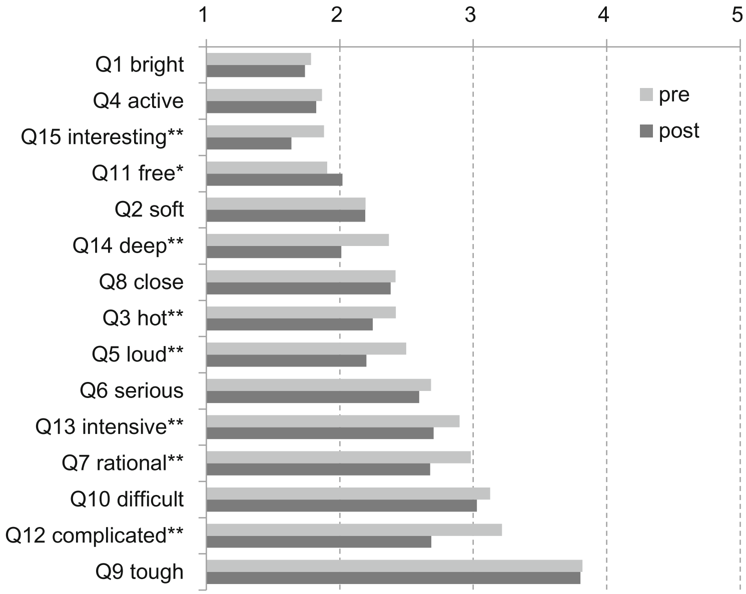

Fig. 1 Group A's means for each item in the pre- and post-surveys

Table 2 shows Group B's means in the pre- and post-surveys and the results of the *t*-test. Figure 2 shows a diagram of the respective means in Table 2, arranged in pre-survey ascending order. As shown in Table 2 and Fig. 2, the four lowest mean scores in the pre-survey were for Q1 bright-dark, Q4 active-inactive, Q11 free-bound, and Q15 interesting-uninteresting. That is, respondents perceived g/s as bright, active, free, and interesting. This perception slightly changed in the post-survey; respondents perceived g/s as more interesting. On the other hand, the two highest mean scores in the pre-survey were for Q9 tough-enjoyable and Q12 complicated-simple beyond the midpoint of the scale (3). Therefore, respondents initially perceived g/s as enjoyable and simple. At the end of the course, respondents continued to perceive g/s as enjoyable but no longer perceived it as simple as before. Six items differed significantly between the pre- and post-surveys as shown in Table 2: Q3, Q7, Q10, Q12, Q14, and Q15. Again, note that g/s was conceived as simple before the course and as complicated after.

Here, let us compare Tables 1 and 2. Regarding the pre-survey, Group A's means were significantly different from Group B's in Q1, Q2, Q4, Q5, Q9, Q11, Q14, and Q15. In all these items, Group B's means were closer to the midpoint of the scale (3). Regarding the post-survey, Group A's means differed significantly from Group B's in Q1, Q2, Q3, Q4, Q5, Q9, Q10, Q11, Q13, Q14, and Q15. In these 11 items, Group B's means were closer to the midpoint of the scale (3) than Group A's except for Q10. As a whole, Groups A and B showed similar tendencies (Figs. 1 and 2) but those in Group B were generally more moderate than those in Group A.

Table 2 Group B's means in the pre- and post-surveys and the results of the *t*-test

	Pre-survey's mean (SD)	Post-survey's mean (SD)	t-value
Q1 bright-dark	2.02 (0.75)	2.03 (0.74)	0.15
Q2 soft-hard	2.31 (0.83)	2.43 (0.78)	1.94
Q3 hot-cold	2.43 (0.79)	2.56 (0.75)	2.23*
Q4 active-inactive	2.06 (0.91)	2.08 (0.80)	0.19
Q5 loud-quiet	2.65 (0.81)	2.65 (0.81)	0.06
Q6 serious-unserious	2.63 (0.81)	2.63 (0.82)	0.13
Q7 rational-emotional	2.88 (0.75)	2.72 (0.81)	2.35*
Q8 close-far	2.48 (0.83)	2.50 (0.73)	0.38
Q9 tough-enjoyable	3.47 (0.99)	3.50 (0.95)	0.43
Q10 difficult-easy	2.99 (1.09)	2.76 (0.89)	2.90**
Q11 free-bound	2.11 (0.77)	2.18 (0.80)	1.20
Q12 complicated-simple	3.15 (0.94)	2.68 (0.85)	6.52**
Q13 intensive-mild	2.99 (0.90)	3.04 (0.82)	0.71
Q14 deep-shallow	2.54 (0.85)	2.19 (0.78)	5.20**
Q15 interesting-uninteresting	2.14 (0.90)	1.96 (0.93)	2.39*

The number of respondents is 248
SD Standard deviation
*$p < 0.05$; **$p < 0.01$

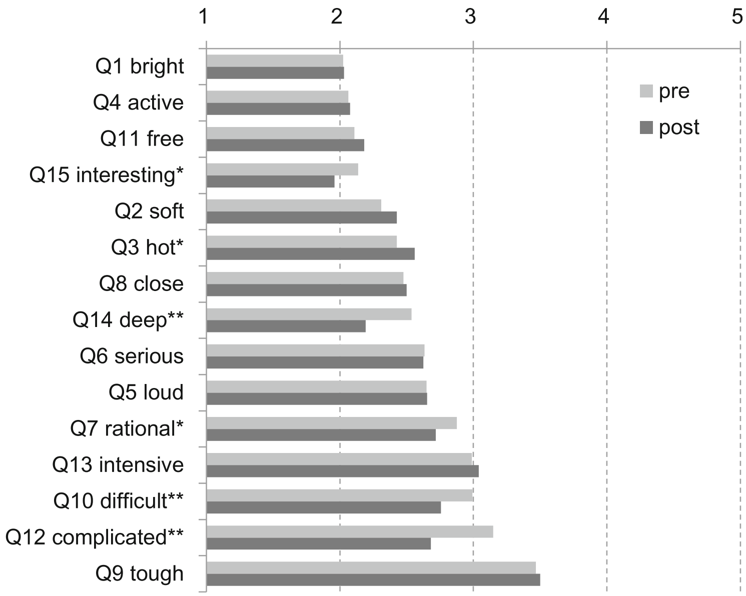

Fig. 2 Group B's means for each item in the pre- and post-surveys

5 Results of Factor Analyses

To more thoroughly investigate the differences between the pre- and post-surveys, the same data were analyzed using exploratory factor analysis. Four groups of data were analyzed: pre-survey for Group A, post-survey for Group A, pre-survey for Group B, and post-survey for Group B. Through exploratory factor analysis, factors with eigenvalues over 1.0 were identified. From the data of the pre-survey for Group A, four factors were identified. Table 3 shows the factor loadings for each item. The first factor, labeled "enthusiasm," consisted of "bright, active, loud, hot, intensive, and close." The second factor, labeled "complexity," consisted of "complicated and difficult." The third factor, labeled "attractiveness," consisted of "interesting, deep, and enjoyable." The fourth factor, labeled "seriousness," consisted of "serious and rational." As shown in Table 4, there were moderate positive correlations between Factors 1, 3, and 4, suggesting that enthusiasm, attractiveness, and seriousness were associated with each other. Factor 2 showed

Table 3 Result of factor analysis of the pre-survey for Group A

	Factor 1	Factor 2	Factor 3	Factor 4
Q1 bright-dark	0.683	–0.019	0.021	0.176
Q4 active-inactive	0.666	–0.043	–0.093	0.194
Q5 loud-quiet	0.620	0.053	–0.027	–0.189
Q3 hot-cold	0.480	0.000	0.116	–0.053
Q13 intensive-mild	0.446	0.217	0.035	–0.186
Q8 close-far	0.406	0.013	0.090	0.059
Q2 soft-hard	0.233	–0.091	0.191	0.177
Q12 complicated-simple	–0.101	0.814	0.305	0.166
Q10 difficult-easy	0.155	0.688	–0.117	–0.074
Q15 interesting-uninteresting	0.215	0.009	0.670	–0.066
Q14 deep-shallow	–0.053	0.305	0.541	–0.025
Q9 tough-enjoyable	0.046	0.370	–0.536	–0.017
Q11 free-bound	0.216	–0.136	0.311	–0.177
Q6 serious-unserious	–0.005	0.080	–0.037	0.567
Q7 rational-emotional	–0.026	0.028	–0.087	0.431
Eigenvalue	3.652	1.892	1.359	1.106

Principal factor method, promax rotation

Table 4 Inter-factor correlations in the pre-survey for Group A

Subscale name	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1: enthusiasm		–0.135	0.541	0.311
Factor 2: complexity			–0.353	–0.230
Factor 3: attractiveness				0.493
Factor 4: seriousness				

negative correlations with the other three factors, suggesting that complexity was negatively associated with enthusiasm, attractiveness, and seriousness.

From the data of the post-survey for Group A, four factors were identified (Table 5). The first factor, labeled "amusingness," consisted of "interesting, soft, bright, free, and enjoyable." The second factor, labeled "excitement," consisted of "intensive, loud, and hot." The third factor, labeled "seriousness," consisted of "serious and rational." The fourth factor, labeled "complexity," consisted of "complicated and difficult." As shown in Table 6, there were moderate positive correlations among four factors, suggesting that amusingness, excitement, seriousness, and complexity were associated with each other. Comparing the pre- and post-surveys (Tables 3, 4, 5, and 6), a function of complexity seemed to change.

Complexity functioned negatively in the pre-survey and came to function positively in the post-survey. The 15-week experience must have caused this change.

From the data of the pre-survey for Group B, four factors were identified (Table 7). The first factor, labeled "liveliness," consisted of "bright, soft, active, hot, loud, close, interesting, and free." The second factor, labeled "severity," consisted of "tough, difficult, complicated, and intensive." The third factor, labeled

Table 5 Result of factor analysis of the post-survey for Group A

	Factor 1	Factor 2	Factor 3	Factor 4
Q15 interesting-uninteresting	0.851	–0.208	–0.046	0.190
Q2 soft-hard	0.567	–0.157	0.077	–0.074
Q1 bright-dark	0.547	0.097	0.138	–0.105
Q11 free-bound	0.531	0.054	–0.149	–0.054
Q9 tough-enjoyable	–0.517	–0.011	0.034	0.269
Q8 close-far	0.297	0.247	0.062	–0.022
Q13 intensive-mild	–0.222	0.626	0.106	–0.024
Q5 loud-quiet	–0.049	0.624	–0.187	–0.031
Q3 hot-cold	0.281	0.421	–0.093	0.083
Q4 active-inactive	0.305	0.387	0.142	–0.058
Q14 deep-shallow	0.184	0.267	0.044	0.245
Q6 serious-unserious	–0.035	0.011	0.624	0.033
Q7 rational-emotional	0.038	–0.067	0.623	0.010
Q12 complicated-simple	–0.040	0.105	0.024	0.619
Q10 difficult-easy	–0.158	–0.079	0.014	0.498
Eigenvalue	3.670	1.743	1.455	1.009

Principal factor method, promax rotation

Table 6 Inter-factor correlations in the post-survey for Group A

Subscale name	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1: amusingness		0.542	0.317	0.285
Factor 2: excitement			0.221	0.460
Factor 3: seriousness				0.444
Factor 4: complexity				

Table 7 Result of factor analysis of the pre-survey for Group B

	Factor 1	Factor 2	Factor 3	Factor 4
Q1 bright-dark	0.766	–0.100	–0.051	–0.062
Q2 soft-hard	0.719	–0.074	–0.036	–0.083
Q4 active-inactive	0.658	–0.029	0.027	0.045
Q3 hot-cold	0.576	0.187	0.308	–0.162
Q5 loud-quiet	0.542	0.283	–0.201	–0.004
Q8 close-far	0.513	0.010	–0.006	0.151
Q15 interesting-uninteresting	0.454	–0.288	0.046	0.333
Q11 free-bound	0.416	0.035	–0.136	0.105
Q9 tough-enjoyable	–0.062	0.782	–0.044	–0.039
Q10 difficult-easy	–0.062	0.724	–0.077	0.119
Q12 complicated-simple	–0.038	0.547	0.148	0.151
Q13 intensive-mild	0.267	0.419	0.055	–0.036
Q6 serious-unserious	–0.106	–0.031	0.656	–0.022
Q7 rational-emotional	–0.065	0.024	0.598	0.101
Q14 deep-shallow	0.042	0.175	0.041	0.747
Eigenvalue	3.757	2.391	1.478	1.044

Principal factor method, promax rotation

Table 8 Inter-factor correlations in the pre-survey for Group B

Subscale name	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1: liveliness		0.058	0.325	0.271
Factor 2: severity			0.165	0.072
Factor 3: seriousness				0.268
Factor 4: depth				

"seriousness," consisted of "serious and rational." The fourth factor, labeled "depth," consisted of "deep." As shown in Table 8, there were moderate positive correlations between Factors 1, 3, and 4, suggesting that liveliness, seriousness, and depth were associated with each other. Factor 2 showed little relationship with Factors 1 and 4, suggesting that severity was not associated with liveliness and depth.

From the data of the post-survey for Group B, four factors were identified (Table 9). The first factor, labeled "brightness," consisted of "bright, hot, soft, loud, and active." The second factor, labeled "challenge," consisted of "deep, interesting, serious, and enjoyable." The third factor, labeled "difficulty," consisted of "difficult, complicated, and tough." The fourth factor, labeled "rationality," consisted of "rational." As shown in Table 10, there was moderate positive correlation between Factors 1 and 2, suggesting that brightness was associated with challenge. Factors 2 and 3 showed moderate negative correlation, suggesting that challenge was negatively associated with difficulty. Comparing the pre- and post-surveys (Tables 7, 8, 9, and 10), "challenge," the second factor in the post-survey, is

Table 9 Result of factor analysis of the post-survey for Group B

	Factor 1	Factor 2	Factor 3	Factor 4
Q1 bright-dark	0.744	0.067	–0.008	–0.026
Q3 hot-cold	0.584	0.021	0.108	–0.018
Q2 soft-hard	0.536	–0.015	–0.158	0.085
Q5 loud-quiet	0.512	–0.082	0.111	–0.111
Q4 active-inactive	0.423	0.378	0.092	–0.016
Q13 intensive-mild	0.363	–0.096	0.270	0.072
Q8 close-far	0.332	0.184	–0.109	0.195
Q14 deep-shallow	–0.026	0.770	0.205	–0.029
Q15 interesting-uninteresting	0.098	0.607	–0.070	–0.027
Q6 serious-unserious	–0.262	0.480	0.110	0.322
Q11 free-bound	0.199	0.277	–0.110	0.028
Q10 difficult-easy	0.020	0.061	0.684	–0.049
Q12 complicated-simple	0.033	0.203	0.626	–0.029
Q9 tough-enjoyable	0.011	–0.402	0.520	0.131
Q7 rational-emotional	0.047	–0.045	–0.036	0.878
Eigenvalue	3.584	1.976	1.530	1.112

Principal factor method, promax rotation

Table 10 Inter-factor correlations in the post-survey for Group B

Subscale name	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1: brightness		0.484	–0.109	0.038
Factor 2: challenge			–0.325	0.131
Factor 3: difficulty				0.135
Factor 4: rationality				

noteworthy. Its four components were derived from four factors in the pre-survey. Therefore, challenge is a blend of all four factors in the pre-survey. The experience of g/s caused such a major change in Group B's perceptions.

In Tables 3, 4, 5, 6, 7, 8, 9, and 10, Q9 tough-enjoyable should be noted. It was closely related with Q15 interesting-uninteresting in Group A (Tables 3 and 5) and it was closely related with Q10 difficult-easy in Group B (Tables 7 and 9). Moreover, in Table 9, Q9 was closely related to both Q15 and Q10. Group B's perception of g/s seems to be as if in the process of shift. In fact, comparing Group B's perceptions in the post-survey (Table 9) with Group A's perceptions in the pre-survey (Table 3), we can observe some similarities. Factor 1 of Table 9 and Factor 1 of Table 3 have four components in common. In the same way, other factors in Tables 9 and 3 overlap to some extent. Therefore, we can say that Group A was one step ahead of Group B in terms of their perceptions of g/s.

6 Discussion

When g/s is properly functioning, players tend to involve themselves in the experience. Duke (1974) named this "gameness," which indicates a player's enthusiasm and willingness to participate. According to the above results, g/s had the power to attract and excite people who were ready to jump into an unknown world. I would like to discuss this readiness from the viewpoint of "flow" theory. According to Nakamura and Csikszentmihalyi (2005), one of the conditions necessary for flow is "perceived challenges, or opportunities for action, that stretch (neither overmatching nor underutilizing) existing skills; a sense that one is engaging challenges at a level appropriate to one's capacities" (p. 90). When skills are low and challenges are high, anxiety (or arousal or worry) will occur. When skills are high and challenges are low, relaxation (or control or boredom) will occur.

A factor named "severity" in the pre-survey for Group B (Table 7) seems to symbolize an ambivalent attitude toward g/s. For those who perceived g/s as easy or simple, g/s seemed enjoyable, but for those who perceived it as difficult or complicated, it did not seem enjoyable. For the latter, g/s rather causes anxiety, worry, or even fear. The opportunities given by g/s felt overwhelming for some of Group B at the beginning. Through experiencing a 15-week course with g/s, however, they seemed to become ready to tackle the difficulties.

Here, let us observe the difference in circumstances between Groups A and B. Table 11 compares Group A with Group B in terms of several circumstances. First, the type of course was "optional" for Group A and "required" for Group B. With regard to Group A, 95 % of freshmen joined this course. With regard to Group B, it was compulsory for students to join the course. Second, students in Group A intended to study "project management" while those in Group B intended to study "sociology and related areas" such as psychology, social welfare, child care, and tourism. In terms of the university culture, Group A's university was engineering based and Group B's university was social science based. The class size in Group A did not vary as it did in Group B. In terms of diversity, Group A was more homogenous than Group B. Male Japanese were the dominant demographic in Group A, which was also the case in Group B but to a lesser degree than in Group A. The final point concerns classroom environment. For Group A, the classroom was a workroom, which contained 20 large tables, each surrounded by six or eight chairs. The tables were not movable but the chairs were and the room had a great deal of empty space. When participants worked in a group, each group was able to

Table 11 Differences in circumstances between Group A and Group B

Circumstances	Group A	Group B
Type of course	Optional	Required
Major	Project management	Sociology and related areas
University culture	Engineering	Social science
Class size	50–70	30–70
Female ratio	5–15%	20–40 %
Foreigner ratio	0 %	10 %
Classroom	Appropriate space for groups	Inappropriate space for groups

concentrate without being distracted by others. For Group B, on the other hand, the classroom was an ordinary lecture-style room. Neither the desks nor chairs were movable and the room did not have much empty space. When students worked in a group, some needed to turn around and may therefore have felt uncomfortable. Sometimes, participants in different groups needed to sit next to each other and this may have been a source of distraction.

It is likely that the differences shown in Table 11 influenced the difference in perceptions between Groups A and B in the pre-survey and post-survey. First, those who felt hesitation about group activity did not take this course in Group A. Second, because of their field of academic study, most students in Group A seemed less hesitant to engage in group work than those in Group B. These features seemed to make Group A one step ahead in terms of their perceptions of g/s at the beginning. However, through the 15-week experience, students in Group B shifted to adopt the perceptions of g/s held by those in Group A in the pre-survey. Therefore, a major change must have occurred during the course. "Gameness" probably contributed to reducing their anxiety. Class size and/or diversity of classmates could also have contributed to so doing.

The biggest change in Group A from the pre-survey to the post-survey was the relation between "complexity" and other factors. "Complexity" was negatively related to other factors in the pre-survey and positively in the post-survey. This indicates that Group A's perceptions of g/s became more inclusive during the course. They may have experienced a sort of "flow" during the course, which could have contributed to changing their attitude toward complexity.

It is hypothesized that attitude toward g/s starts from hesitation and shifts to inclusivity. Future research would be possible in this direction. Learning seems to have occurred through g/s at different levels of readiness in participants. The level of readiness affects participants' willingness to jump into the world of g/s. Those who feel hesitation toward g/s may be able to overcome it through g/s, while those who are ready to enter g/s may be able to develop a wider perspective. In sum, everyone can accrue learning opportunities through g/s. Matching opportunities with capacities is the job of a facilitator, while matching capacities with opportunities is the job of participants.

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References

Duke, R. D. (1974). *Gaming: The future's language*. Beverly Hills: Sage.

Nakamura, M. (2014). The impact of relevant experience and debriefing questions on participants' perception of gaming simulation. In R. D. Duke & W. C. Kriz (Eds.), *Back to the future of gaming* (pp. 200–213). Bielefeld: W. Bertelsmann Verlag.

Nakamura, J., & Csikszentmihalyi, M. (2005). The concept of flow. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 89–105). New York: Oxford University Press.

Ecological Psychology: A Framework for Wargame Design

Staffan Granberg and Patrik Hulterström

Abstract The focus of educational wargame design is to create a training environment to be able to learn different aspects of warfare. This process has traditionally been a practice governed by experience, best practices or an attempt to replicate warfare as realistic as possible. We argue that the use of high fidelity as a guiding principle in wargame design can result in a costly, less effective and less utilitarian design process. In this paper we suggest an approach by using ecological psychology as a theoretical design framework to create educational tactical wargames. Viewing military units and tactics with an ecological psychology perspective of tools and affordances enables us to use a structured iterative design approach to obtain a good-enough wargame design that meets the educational goals.

1 Introduction

The professional use of wargames has a long history in military education and training (Perla 1990). Wargames can be used for different purposes, but this paper will focus on wargames for training and education of military tactics. Training military tactics in a realistic setting such as commanding real troops and staffs is both costly and unpractical. The use of thousands of soldiers and vehicles to train a handful of tactical decision-makers is not a rational approach. As a result instructors and educators of tactics have had to find suitable substitutes, such as a wargame environment. The focus of educational wargame design is to create this training environment and to make sure the lessons taught are relevant in the world outside the training environment. This process has traditionally been a practice governed by experience and best practices (Rubel 2006). There is thus not any structured approach or common understanding in the professional wargaming discipline, nor a common standard for how to design or conduct wargaming (Rubel 2006). Wargame designers would therefore benefit from a theory that helps them to

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understand the relation between the domain of military tactics and the wargame as well as the relation between the wargame and the student to understand the process of learning.

A traditional approach would be to try to replicate the decision environment for a commander with as high resolution as possible, i.e. to use high fidelity as a guiding principle to create the wargame. This approach is adopted in simulator training, for instance, in pilot training, where the goal is to imitate the real cockpit as accurately as possible. We argue that this approach for designing wargames is not a fruitful approach, because of the difference in scope and educational goals between simulator training and educational wargames. The focus on fidelity can result in a costly, less effective and a less utilitarian design process (Kozlowski and DeShon 2004; Sergant 2005).

In this paper we suggest an alternative approach by using *ecological psychology* (Gibson 1966, 1986; Gibson 2000) as a theoretical design framework for creating educational wargames. Our approach follows the work of Linderoth who uses the ecological psychology theory as a framework to analyse gameplay and what people learn by using entertainment games (Linderoth 2012). Using ecological psychology as a theoretical framework for wargame design helps us to view what is supposed to be learnt in a more structured way. And it is also a useful framework for instructors thinking about the wider learning context of using wargames. Our approach thus enables us to use a structured iterative approach to find a good-enough wargame design that insures that the wargame will meet the educational goals.

2 Theoretical Approaches to Wargame Design

Designing wargames has been considered something of an art (Perla 1990). There have been few attempts to connect wargame design to a theoretical foundation. The most common approach has been to look at adjacent fields for theoretical support. When looking for a theory to support wargame design, the main choice has been to use a similar design approach as for simulators. Simulators have a widespread use in the military domain and are therefore often referred to in the design of wargames. Similarities exist between simulators and wargames, as they share the use of models (McHugh 2011). In wargames models are one component of the game, which are used to keep track of military units and how they interact with each other (Perla 1990). This common use of models has resulted in the application of a similar design approach on wargames (Rubel 2006). We argue that this is not a fruitful approach for wargame design because there is a big difference in scope and educational goals between simulator training and educational wargames. This distinction between the difference in goals and epistemology has been observed and discussed in other closely related fields, like business simulation studies (Klabbers 2009).

The traditional approach in simulator training is the concept of *fidelity* (Salas et al. 1998; Kozlowski and DeShon 2004). It assumes that the more similarity shared between the simulation and the activity being trained, the better the training (Salas et al. 1998). This traditional view is not without its problems and there seems to be a point, where fidelity loses the ability to increase learning and the broader context of the learning environment becomes more important (Salas et al. 1998; Frank 2014). Research results now question the increased fidelity approach and look at how one can conduct successful training with low-fidelity simulations (Salas et al. 1998; Waldenström 2012). The use of high-fidelity simulator training is a tested and proven approach, but it seems that it is not the most effective approach to address all types of educational goals (Kozlowski and DeShon 2004).

Simulators using the high-fidelity approach are often designed to train a specific set of skills, i.e. *part task trainer* or how to operate a specific vehicle system, i.e. a *cockpit simulator*. Wargames do not necessarily train a specific skill that corresponds with an existing predefined role. It trains a wider broader set of skills used for decision-making; in the domain of military tactics (Perla and McGrady 2011), this makes wargames more comparable to the research conducted in the field of decision-making research. In this field of research, human behaviour and cognition are the main objects of study. Microworlds are used to provide the user with the experience of the relevant phenomena and problems to be able to study the users' decision-making process. This research field has had to tackle the problem of using simple simulations/games to study broader problem-solving skills. "Generalization is possible only if the theory we derive is valid both for the micro-world and the situation outside the laboratory that we are interested in" (Brehmer 2004, p. 26).

Brehmer argues that the key point of the microworld is that it should be theoretically relevant to the problem domain that we are interested in. The physical aspect, i.e. the physical features of the microworld, is of less importance; it is the psychological aspects that are relevant. This brings us to the difference between *physical fidelity* and *psychological fidelity*. The concept of psychological fidelity is concerned with to what extent the training environment prompts the relevant underlying psychological processes (Kozlowski and DeShon 2004). This approach seems much more relevant and a better fit for wargames, because it also addresses simplified simulations/games to explore broader cognitive problem-solving skills.

Psychological fidelity has been used as a design guideline in developing microworlds, but the challenge is how to determine what these theory relevant problems are and how to implement them in the design. One approach to address this challenge is *cognitive task analysis* (Kozlowski and DeShon 2004). CTA uses a variety of observation and interview techniques, to produce a description of the knowledge of domain experts. From this description we can extract the problem space, which can then be used as a basis for constructing the microworld. Military tactics has generally not been treated as a cognitive problem but more as an art, which means that mapping the tactical decision-making domain is not yet a practical or cost-effective approach for us when designing educational wargames.

3 The Knowledge Domain: Military Tactics

In a general understanding, tactics can be understood as a course of action, i.e. an idea of how to use your assets to achieve an objective. Different parties can have opposing objectives that will result in an adversarial situation. In a military context, the adversarial situation is manifested through combat. One of the most cited writers on warfare is Carl von Clausewitz who defines tactics as: "[. . .] *the theory of the use of military forces in combat*." (Clausewitz 1997, p. 75). Combat or the violent interaction is what signifies the military context. Regardless of the objectives that lead up to the confrontation, the violent interaction becomes its own objective. The inherent objective of combat will always be to defeat the opponent or at least avoid being defeated by the opponent. Tactics in a military context therefore always concerns at least two parties/forces with opposing objectives.

It can be argued that combat primarily is about the use of force to achieve an objective and that all other activities in combat are to enable the use of force (DuBois et al. 1997). These combat activities or capabilities can be categorized in different ways. One way to categorize them is in six primary combat functions; *command-control*, *force*, *endurance*, *intelligence*, *mobility* and *protection* (Sörenson and Widen 2014). *Force* is the capability to produce effect with the use of weapons. In order for force to have an effect, units need to know where and when to use it; this requires gathering and analysis of information under the *intelligence* capability. To get weapon systems and sensors within range of a target or to get out of the opponent's range, units have *mobility*. A unit's capability to operate over time and distance is *endurance* and with *protection* comes the capability to sustain and or prevent harmful effects from hostile activities by the opponent. To direct and coordinate different military units towards the objective is to have the capability of *command and control*. These combat functions are the same for all forces and the parties use them to achieve their objectives and counter the opponent's actions. This creates a mutual structure in the combat environment in that the parties try to achieve objectives in the same space with the same set of functions against each other. Although the parties share the situation and the structure, they do not necessarily have the same capabilities, nor do changes in the situation affect the conflicting parties in the same way (DuBois et al. 1997). This difference in capability is more explicable when looking at the military units that the combat functions are manifested through. For example, in an air-defence frigate, the intelligence function is manifested through radars and the force function through surface to air missiles, and in a submarine the intelligence function is manifested through sonars and the force function through torpedoes. The situation also affects these vessels differently. A frigate is affected by sea states and weather in a different way than a submarine is. But they also affect an opponent differently since a frigate and a submarine pose different types of threats. A commander with several different units at his/her disposal therefore also has many different courses of actions that can be taken to achieve the objective. Which of the many possible courses of action is the most suitable depends on the situation, which naturally changes over time as a result of once own and opponents' actions. In this dynamic environment, opportunities emerge but also risks. The commander has to recognize the opportunities and the risks and also understand how to exploit the opportunities and manage the risks to be able to achieve the objectives.

This is the essence of tactics in the military domain. Tactics is the way a commander organizes and orchestrates combat functions over time to reach the objectives, with an ability to see and make use of opportunities while managing risks. Therefore we believe that the process of learning tactics is to learn how to analyse available units from a combat function's perspective and then arrange and utilize these functions in relation to the situation and the opponent to achieve the objectives. With this view on tactics, we turn to ecological psychology before explaining how this theory can be applied to learning tactics and wargame design.

4 Ecological Psychology and the Concept of Affordances

Ecological psychology is a theory founded on James Gibson's work in the field of visual perception (Gibson 1966, 1986). It has its roots in the radical empirical theory tradition (Heft 2001). Its epistemological stance is based on direct perception; thus the idea is that meaning is not created in the mind of individuals but is a result of our interaction with the environment. Meaning is thus in the environment and the individual gathers it through perception (Chemero 2003). This contradicts the more physicalistic ontology as it implies that because there is meaning in the environment, there are parts of the world that are not only physical (Chemero 2003). It has therefore been necessary to form a new ontology to explain this contradiction (Chemero 2003). This new view was inspired by biological systems, where beings and their environment form a dynamic system, and that meaning arises as a result of these beings-environment relations.

Affordance is the core concept in ecological psychology (Gibson 1986; Gibson 2000). We define affordance as *a resource that the environment offers to a specific agent*, *who in turn has both the capability to see and use it*. Affordances thus describe the relationship between beings and the environment and meaning. This is often misinterpreted in the way that affordances are viewed as features in the environment that offers a possibility for interaction, but affordances are relations *between* the abilities of the agent and the features of the environment. A chair offers the affordance of sitting to most humans, but not to a horse. Affordances are thus not only properties of the environment but are also relative to the agent. One can view this as affordances being features of whole situations and not just a property of the environment (Chemero 2003). If affordances are relative to the agent, then there are some factors that limit what affordances are open to an agent. The agent is first limited by his *abilities* and, secondly, by what affordances he can *perceive* and finally by *events* that occurs in the environment (Chemero 2003).

What affordances are available to us is dependent on our *abilities*. Abilities can be divided into *physical dispositions*, *skills* and what *tools* we have at our disposal.

Physical dispositions are linked to our bodies and physical limitations as they limit what we can do and how we can interact with the environment. A tree affords climbing to a monkey but not to a zebra, and a small hole in the ground affords hiding to a rabbit but not to an elephant. Acquiring new skills can increase our range of possibilities to interact with the environment. A human cannot normally cross a lake, but we can cross the lake if we have the skill of swimming (and hopefully the physical disposition of sufficient endurance).

There are other ways to interact with the environment beyond only using your body, which brings us to the concept of tools; "A tool in the most general sense is an object that extends the capacity of an agent to operate within a given environment" (Ingold 1993, p. 433). Humans have the option to use tools to access more affordances which gives us abilities beyond our physical constraints to affect the environment. A ladder opens up the possibility to climb to the roof of a tall building. Climbing the roof of the building was not an affordance until the agent received the tool and acquired the skill to use it. Tools can also affect the agents' ability to make decisions. Binoculars are tools that give the agent the ability to see further and act on information he would not otherwise have access to. Tools can be very simple devices such as a stick or a stone, yet humans have the ability to create much more advanced tools. An airplane can be viewed as a tool that extends our abilities and opens up the affordance of flying. Most advanced tools require skills to use them; simulators like cockpit simulators are designed to help us learn these types of advanced skills.

Having the ability is not always enough, we have to see and understand what affordances are available to us. *Perceiving* an affordance is to conceptualize a relation between agent, affordance, ability and environment (Chemero 2003). The primary way to learn to see new affordances is by interacting with the environment; we perceive the world and are over time able to make finer distinctions in the environment (Gibson 2000). Ecological psychology theory thus views learning as a process of becoming attuned to our environment. Discovering new affordances is not only possible through direct interaction with the environment. We can learn about affordances through other people who can make descriptions of conceptualized affordances available to us (Heft 2001). These conceptualized affordances have been one way humanity has been passing on knowledge from one generation to the next. Learning in relation to a defined profession or practice is thus about learning to use a specific set of affordances that relate to that profession or practice (Linderoth 2012).

The world is not a static environment; some features change very slowly, while others may change more frequently. These changes affect what affordances are open to us, and we constantly scan our surroundings for new opportunities. These changes and opportunities are in ecological psychology called *events*. Events are changes in the layout of affordances (Chemero 2003); we view this as changes in the relation between ability, agent and the environment. The environmental situation can change because of changes in any of these entities. I can walk on the lake because it is now covered with ice. I can now catch the bird because it flew down from the top of the tree to the ground (environment change). I can now climb the wall because I have improved my climbing skill (ability). One part of getting attuned to the environment is to learn to recognize these temporary changes in the environment (events) and connect them to what affordances they provide.

5 Tactics Seen Through the Lens of Ecological Psychology

We have argued that tactics is the idea of how to use your assets in an adversarial situation to achieve an objective. The tactical situation consists of your assets and the objective, the opponent's assets and objective and the constraints of the physical world. These components create a tactical environment, and to master this environment is to have a tactical ability. In ecological psychology the principal idea is that there is a dynamic relationship between the individual and the environment. We learn by observing and acting in the environment to discover affordances. By this continuous process, the agent starts to become attuned to the environment, i.e. the agent starts to understand and gradually master it.

Applying this theoretical view to the military domain suggests that tactics is connected to affordances, as tactics refers to understanding what possibilities for action a situation provides. Since what we are able to do is dependent on what abilities we have, we must first learn to understand these abilities. For a commander in a tactical situation, this is the same as understanding the possibilities and limitations of subordinate military units. It is only through these military units we can influence the environment to achieve the military objectives. The military units can therefore be seen as tools in an ecological psychology perspective. The idea to apply ecological psychology to gaming environment is suggested by Linderoth (2012) who propose that "*the function that is tied to the player's agency can be understood as a tool*". Understanding what the tools can do and how best to utilize them is therefore an important component of tactical ability.

The tactical environment consists of both variant and invariant structures. The physical properties of the environment seldom change from a tactical perspective; the geography and terrain remain invariant regardless of the situation, but the commander's own actions and the opponent's actions will open up or prevent certain affordances. The opponent is thus the single most important factor in the environment. Each side becomes a part of the other side's tactical environment. Therefore if one side does something to affect the opponent, that side also affects its own and the opponent's tactical environment. This creates a dynamic environment. Because the environment is dynamic, the commander has to be able to understand how changes in the environment affect his/her possibilities for action. Part of becoming attuned to the environment is to learn to recognize these environmental changes, i.e. situations, and learn to connect them to a certain affordance.

To summarize, when faced with a tactical problem, the agent will learn how the tools, i.e. the military units, work by exploring different ways of using the tools to deal with the problem. The agent will also learn to identify different situations or *events* in the environment and what affordances they offer. The agent is thus discovering and testing affordances, finding out which ones are successful and which ones are not. By doing so the agent learns how to solve tactical problems, i.e. gaining a tactical ability. Ecological psychology thus provides us with a framework for how we can see military tactics and what it means to have a tactical ability. Along this line, and as the theme in this paper, this also provides us with a theoretical design framework when creating educational wargames to be used for tactical training.

6 Implications for Wargame Design

The core of ecological psychology is that humans learn to master an environment by perceiving and exploring affordances. Part of this exploration is also to learn to appropriate the tools we have to our disposal and to recognize events that prompt certain affordances. When applying this theoretical reasoning to tactics, we see a military commander as an agent making efforts to control the tactical environment, i.e. the battlespace, by making use of his/hers tools, i.e. military units. Affordances thus emerge in the perceptual field of the commander as he/she sees what tactics *can* be employed in any given situation.

Designing a wargaming environment for tactical education follows the same logic. In exploring the wargame environment, one will discover affordances and learn how to utilize different tools. If the affordances that appear as a result of the agent-environment-tool interaction match the educational objectives, we have a design that serves our purpose. This means that the goal of the design process is to assure that the appropriate affordances are able to emerge and to provide opportunities for the learner to get attuned to this environment. Given the nature of affordances, we cannot directly design them as they are abstract concepts, which mean we must focus our efforts at designing tools and other characteristics of the environment. If the desired affordance appears as a result of interaction, we are assured that the characteristics of the tools and environment are designed in a suitable way.

From a design perspective, this theoretical thinking will also provide guidance to separate between what needs to be included in the design and what is not necessary. However, it will put emphasis on the requirements of the characteristics in the design elements of the wargame. The combat functions will act as a good starting point when we address what characteristics each tool must have. Viewing the military units as tools puts the design focus on how the tools extend our agency, i.e. their characteristics and functions, which will result in a function and not fidelity perspective when we design. This functional perspective means that we can approach the wargame design with a good-enough philosophy, as opposed to strive for high fidelity to create a game environment that replicates every detail and aspect of warfare. The level of fidelity required when modelling the different functions of a unit is then guided by if the desired affordances are able to emerge in the game environment as a result of agent-environment-tool interaction. The tools, i.e. military units in the wargame, can be anything from a ship or tank to larger aggregated units as brigades or battalions; the combat function perspective is still relevant and helpful regardless of the degree of aggregation. This gives us the opportunity to work in a structured iterative approach by starting with a very simple representation of the environment and then adding features and tools until the wargame is able to reproduce the affordances we are interested in. This approach will result in a more efficient design process as it opposes the idea that the gaming environment needs to replicate warfare as realistic as possible for relevant learning to occur.

When we view tactics through the lens of ecological psychology, we can start to structure military tactics by connecting tactical situations to affordances. And this in turn assures that the wargame design connects to the educational goals. However, just because an affordance is present in the wargame design does not mean students will necessarily discover it. Therefore we must rely on instructors in the use context, i.e. when the game is being played and the tactics is being employed, to manage the learning process and to determine if the students have met the educational objective.

In naval surface warfare, for example, the relation between sensor ranges and weapon range defines the tactical environment. Control of the sea is vital in most naval missions, which means that the commander needs to establish control by locating enemy ships in the area of interest to eliminate the potential threats. To locate the enemy ships, the commander uses different types of sensors; the most important type is radar. The typical ship radar has a range of 60 km, but radar also has a drawback. Naval ships are equipped with radar detection equipment, and this equipment can detect radar energy at a distance of 90 km from the emitting source. This creates a dilemma; if you use your radar to detect an enemy ship that is outside your radar range, your enemy is able to use his radar detection equipment to establish your position. The second part of the problem is that you can shoot longer than you can detect, as antiship missiles typically have a range of 200 km. This means that a ship can scout using radar, but other ships farther away fire the missiles. To use your sensors in a tactically correct way thus becomes vital to be successful in the naval surface warfare environment. This example illustrates how the relation between the combat functions of intelligence (sensors such as radars) and force (weapon systems) generates different tactical problems the learner must overcome. Affordances in our example are created by all those opportunities and constraints provided by the sensors and weapon systems on both sides. When played in a wargame session, we can observe what affordances the students can perceive and what type of actions the students take to overcome the different challenges. Progressively the players learn to use intelligence and force wisely as he/she becomes attuned to the environment. Since the opponent is a vital part of the commander's tactical environment, and thereby affects the commander's affordances, understanding the situation from the opponent's point of view becomes an important part of tactical education/training. One way to achieve this understanding of the opponent's perspective is to use two-sided games. Using two-sided games makes it possible for the students to play both sides and consequently experience the affordances of both sides and how these affect each other. From a design perspective, we start with this simplified description of the naval tactical environment. We can look at what tools we need to design and what characteristics they need to have. Even a simple version will start to produce the cognitive problems that we want the player to experience and learn how to handle. Subject-matter experts can start the process of testing and evaluating the simple representation to see what affordances are missing. The designer will continue to refine the game environment until all the desired affordances appear, i.e. the relevant limitations and possibilities of using the sensors and weapons to detect and destroy enemy naval ships. We can also hunt down affordances that are irrelevant to the target domain, i.e. game artefacts which can produce negative training effects (Frank 2014; Rubel 2006).

7 Conclusions

Training military tactics in the real world is both costly and unpractical. Wargames are therefore used to provide an artificial training environment. The problem with a game environment is how to make sure that what is taught in the wargame is relevant to the target domain. We have in this paper argued that ecological psychology can be used as a theoretical framework for wargame design to better understand and overcome this problem. By using affordances as a starting point for the design process, ecological psychology theory can be used to explain how low-fidelity designs can be made to work and what types or approaches to simplification will not. We argue that viewing the military units as a tool helps us to better understand how they should be designed, and what level of fidelity will be required, which makes it possible to use a structured iterative approach to find a good-enough wargame design that still insures that the wargame will meet the educational goals.

8 Discussion

We have designed two games using this approach, and they have been used for 5 years in the *Swedish Defence University* with good results (Waldenström 2012). The effectiveness of using games in military education is generally not questioned. The question for further research is to explore why it works and how do we improve its effectiveness. A similar situation is found in the field of business games, where there is evidence of the game's effectiveness, but less research on how to further improve its effectiveness (Wolfe 1997). Therefore we need to further validate the results and not just rely only on student and teacher satisfaction measurements. We need to conduct empirical studies to provide evidence for the link between the affordance design framework and fulfilment of learning goals.

Furthermore we need to develop a more structured and effective method for identifying affordances from the educational goals. The goals are often described on a higher more abstract level, and they are not always useful as a reference for identifying affordances. This requires that designers work closely with the *subject-matter experts* to break down the educational goals to a more concrete usable level. Another implication is that validation of the design is only possible through iterative testing of the game environment; thus designers must have regular access to SME support for this design approach to be successful.

Finally, a wargame design that allows the appropriate affordances to emerge does not necessarily produce a self-explanatory learning tool. The most important factor for promoting learning is the wider use context. Instructors must actively guide the students to make sure that the right affordances are discovered and understood. And postgame debriefing is a vital activity to reinforce the learning goals (Crookall 2010; Alklind Taylor 2014). We suggest that coaching and debriefing also could benefit from our proposed framework, because viewing the wargaming activities through the lens of affordances and tools helps the instructor to structure the subject matter and makes sure that the feedback also connects to the learning goals.

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References

Alklind Taylor, A.-S. (2014). *Facilitation matters a framework for instructor-led serious gaming*. Skövde: University of Skövde.

Brehmer, B. (2004). Some reflections on microworld research. In S. Schiflett, L. Eliott, E. Salas, & M. Coovert (Eds.), *Scaled worlds: Development, validation and applications* (pp. 22–36). Burlington: Ashgate Publishing Company.

Chemero, A. (2003). An outline of a theory of affordances. *Ecological Psychology, 15*(2), 181–195.

Clausewitz, C. V. (1997). *On war*. (J. J. Graham, Trans.). Hertfordshire: Wordsworth Editions Limited.

Crookall, D. (2010). Serious games, debriefing, and simulation/gaming as a discipline. *Simulation & Gaming, 41*(6), 898–920.

DuBois, E. L., Hughes, W. P., & Low, L. J. (1997). *A concise theory of combat*. Monterey: Institute for Joint Warfare Analysis at Naval Postgraduate School.

Frank, A. (2014). *Gamer mode identifying and managing unwanted behaviour in military educational wargaming*. Stockholm: KTH Royal Institute of Technology.

Gibson, J. J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin.

Gibson, J. J. (1986). *The ecological approach to visual perception*. Hillsdale: Lawrence Erlbaum Associates Publishers.

Gibson, E. J. (2000). *An ecological approach to perceptual learning and development*. New York: Oxford University Press.

Heft, H. (2001). *Ecological psychology in context*. Manwan: Lawrence Erlbaum Associates Inc.

Ingold, T. (1993). Tool-use, sociality, and intelligence. In K. R. Gibson (Ed.), *Tools, language and cognition in human evolution* (pp. 429–445). Cambridge: Cambridge University Press.

Klabbers, J. H. T. (2009). Terminological ambiguity: Games and simulation. *Simulation & Gaming, 40*(4), 446–463.

Kozlowski, S. W., & DeShon, R. P. (2004). A psychological fidelity approach to simulation-based training: Theory, research and principles. In S. Schiflett, L. Elliott, E. Salas, & M. Coovert (Eds.), *Scaled worlds: Development, validation and applications* (pp. 75–99). Burlington: Ashgate Publishing Company.

Linderoth, J. (2012). Why gamers don't learn more: An ecological approach to games as learning environments. *Journal of Gaming and Virtual Worlds, 4*(1), 45–62.

McHugh, F. J. (2011). *Fundamentals of war gaming* (3rd ed.). Washington, DC: GPO.

Perla, P. P. (1990). *The art of wargaming*. Annapolis: Naval Institute Press.

Perla, P. P., & McGrady, E. (2011). Why wargaming works. *Naval War College Review, 64*(3), 111–130.

Rubel, R. (2006). The epistemology of war gaming. *Naval War College Review, 59*(2), 108–128.

Salas, E., Bowers, C., & Rhodenizer, L. (1998). It is not how much you have but how you use it: Towards a rational use of simulation to support aviation training. *The International Journal of Aviation Psychology, 8*(3), 197–208.

Sergant, R. G. (2005). Verification and validation of simulation models. In *Proceeding WSC '05 Proceedings of the 37th conference on winter simulation*, pp. 130–143.

Sörenson, K., & Widen, J. J. (2014). Irregular warfare and tactical changes: The case of Somali piracy. *Terrorism and Political Violence, 26*(3), 399–418.

Waldenström, C. (2012). Using a low-fidelity wargame for training fleet-level command and control in the classroom. In *Proceedings from the 17th international command and control research and technology symposium*. Washington, DC: Department of US secretary of defence.

Wolfe, J. (1997). The effectiveness of business games in strategic management course work. *Simulation & Gaming, 28*(4), 360–376.

Part II
Classroom Fields

Understanding and Changing Systems Through Hybrid Simulation Game Design Methods in Educational Contexts

Willy Christian Kriz and Werner Manahl

Abstract This paper presents an innovative university curriculum for systems management education. Over the course of three consecutive semesters, Master's degree students take one seminar per semester about systems thinking techniques, system dynamics, and agent-based modeling. The design of hybrid simulation game prototypes is part of this didactic approach. In the first parts of the paper, we discuss the building blocks of gaming simulation, principles of gaming simulation and learning, and gaming simulation's potential to improve the understanding of and ways to change systems. In the last part, the structure, contents, and game design approach of the university curriculum are shown in detail.

Keywords Systems thinking • Management • Education • Simulation game design

1 Gaming Simulation for Understanding and Changing Systems

Public policy makers and leaders of organizations increasingly face difficult problems and highly complex situations and dynamics. Unfortunately, abilities and strategies to deal with complex dynamic systems have not improved to the required extent. Leaders and managers fail to handle the complexity of a modern world in crisis, and they are not dealing with limited resources in a sustainable and humane way. Many decision makers do not take into account the interconnectedness of systems processes and have difficulties integrating knowledge from various scientific disciplines.

To survive, people, groups, and organizations need to adapt continuously to changing internal and external conditions. Therefore, human beings and social systems must be able to learn. Leaders and managers increasingly need methods they can use to:

- Make complex system dynamics understandable

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- Support problem solving and decision-making
- Investigate the long-term and side effects of decisions
- Develop and explore alternative change strategies for possible better futures
- Create learning environments to instill players with the required knowledge and skills for implementing and sustaining the desired changes

Gaming simulation methods have the potential to fulfill these needs and to contribute to the transformation of organizations and other real-life systems. Klabbers (1989, p. 3) pointed out 25 years ago:

> *As problems and issues are becoming increasingly complex, how can we improve our individual and collective competence in steering and self-steering our societies, organizations and institutions? . . . Gaming and Simulation have proved to be a powerful combination of methods and ideas in dealing with complex and unique issues . . . Gaming Simulation provides a language for combining the social-human domain with the physical, technological and economic domains and provides a shared language for communication between the natural and social sciences.*

Including reference to the interconnections among different life areas in decision-making processes is called systems thinking (Senge 1990). Systems thinking involves a holistic and cybernetic approach, taking into account as many different factors as possible to avoid interpreting problems from a single point of view. A range of likely outcomes and possible effects of planned actions can thus be considered. Furthermore, it requires an appropriate culture of cooperation, communication, and dialog within organizations. Systems thinking fosters the exchange of mental models and the understanding of social systems. This indicates the need for and value of suitable learning environments to assist the development of relevant competencies ("systems competence"; Kriz 2003).

Richard Duke is considered the founding father of ISAGA. In 1971, he gave his talk at the 2nd ISAGA Conference on "Systems Theory and Gaming-Simulation" (Becker and Goudappel 1972). Duke's classic book "Gaming: The Future's Language" (1974) pointed out the need for gestalt and multilogue communication in dealing with complex systems. Duke detailed why and how gaming simulation supports the holistic understanding of complex systems and the decision-making process for policy makers in different contexts.

Robert Armstrong, one of the organizers of the 8th ISAGA conference, recalled some memories at the organization's 25th anniversary conference. Armstrong stated (1995, pp. 213) that systems thinking, in particular, is one of the core elements of gaming simulation:

> *In retrospect, it is difficult to define precisely the expectations of those who gathered in Bad Godesberg 25 years ago. We were a diverse group brought together by a common interest in the use of gaming-simulation. . . I suggest that there were three concerns in the minds of participants providing us with the common ground for discussion of problems:*
>
> - *A feeling of dissatisfaction with the restrictive nature of the analytical approach to problems in our subject areas*
> - *A wish to explore the potential of a systems approach to societal problems as a framework for the consideration of multi-disciplinary problems*
> - *A desire to refine and extend the use of gaming-simulation in our areas of interest.*

Modern approaches of gaming still refer to these fundamental concerns and arguments (Duke and Kriz 2014; Meijer et al. 2014; Kikkawa 2014). For example, Tsuchiya (2012) discusses principles for organizational transformation by using a combination of policy gaming, game design, and system dynamic modeling.

Klabbers (2014) describes the science of design perspective that puts an emphasis on the usability of simulation games. The focus is on dealing with an interdisciplinary and practical approach to simulation game design as a science, art, and craft that builds on local knowledge and the unique problems or challenges of a social system. He distinguishes two levels of design: "design in the small" and "design in the large." Design in the small produces gaming simulations (gaming artifacts) as interventions and interactive learning environments to enhance education, training, and decision-making. Used with that goal in mind, they contribute to the change and development process ("design in the large") of social systems (Klabbers 2006).

In addition to system dynamic modeling, agent-based modeling and social simulation are combined with the classical approaches of gaming simulation (Deguchi 2004; Kaneda 2012). These modern forms of hybrid gaming simulation are especially promising when used as a group model-building methodology (Fischer and Barnabé 2009) to solve real-life problems together with different stakeholders.

2 Methodology of Gaming Simulation

"Gaming simulation" is the simulation of the effects of decisions made by players who assume the roles and represent the interests of real-life actors, with the latitude to act these roles out being subject to specific rules (Klabbers 2008; Rizzi 2014). Gaming simulation originated with war games. The Prussian army was one the first to use it systematically and widely to plan military strategies and tactics. After the end of the Second World War, gaming simulation expanded into other fields of application. This growth started with the corporate sector and urban planning and later branched into a variety of educational contexts at universities and schools.

In practice, the term "simulation games" refers to a large number of different approaches. These approaches include computer simulation, behavior-oriented role-plays with or without computer-assisted simulation, hands-on board games, practice enterprises, and more recent approaches such as digital and non-digital educational games, game-based learning, and web-based simulation games.

Simulation games represent dynamic models of real situations. They help to mimic processes, networks, and structures of specific existing systems. In addition to mirroring real-life systems, simulation games incorporate players who assume specific roles of real-life actors. The prototype gaming simulation combines role-play and simulation. True simulation games include actors, rules, and resources (Klabbers 1999). Therefore, despite their diversity and variety, all simulation games contain three fundamental elements:

Simulation Resources: A model is a description or representation of a (real) system and/or process that can help to understand how the system and/or process works. A simulation game is a model that is used to simulate an existing real system and/or process (Klabbers 2008, p. 24). With the aid of simulation, it is possible to replicate and investigate systems processes that could or would not be carried out in real life. These processes include simulations of military maneuvers, disaster situations, or pilot training in flight simulators. Simulation games thus offer an opportunity to make the best possible use especially of limited resources and to make the long-term effects of decisions tangible and transparent. Simulation games encourage holistic, interconnected thinking and systems understanding.

Roles for Actors: Besides simulation, role-playing is an integral element of simulation games. In every real-life system (e.g., an organization), the actions of different people or stakeholders with different interests, information, and perspectives are always interrelated. It is precisely this interaction that simulation games replicate. In the game, the players assume the roles of real-life actors. They have a certain freedom as to how they fill the role and interpret the situation. This freedom is necessary for there to be any behavioral and decision-making alternatives, the effects of which can then be observed. With modern concepts of hybrid simulation games, real human actors can also interact with simulated actors.

Game Rules: A game is an activity involving one or more players who assume roles while trying to achieve a goal. Rules determine what the players are permitted to do – including their interactivity, communication, and feedback – or define constraints on allowable actions. The rules may also impact the available resources (Klabbers 2008, p. 24). As early as the 1930s, Johan Huizinga characterized humans as "Homo ludens" and saw games as a fundamental human achievement. Unlike pure play such as a soccer match or a poker game, the simulation game serves to represent reality. Therefore, the frequent bias against simulation games – that they are merely play or that gaming is related to gambling – is unfounded. Simulation games use gaming forms (e.g., role-play, rule-based play) to simulate real-life systems.

Figure 1 illustrates gaming simulation's use of games to simulate system dynamics. Game artifacts are designed as an abstract qualitative and/or quantitative model of a reference system of the real world (i.e., design in the small). The play and debriefing of the game are exercises that allow participants to practice behavior and experience the effects of their decisions in order to understand and transform the simulated system and to implement transformations in the real system (design in the large) in the future. Players represent actors of the reference system and interact while playing different roles, applying rules, and utilizing resources.

Figure 2 shows the perspective of gaming as a process. A part of the existing situation of reality is selected as a reference system for the designed simulation game. The final aim is to change systems structures and processes. To carry out design in the large in the real world, a simulation game (including a specific game

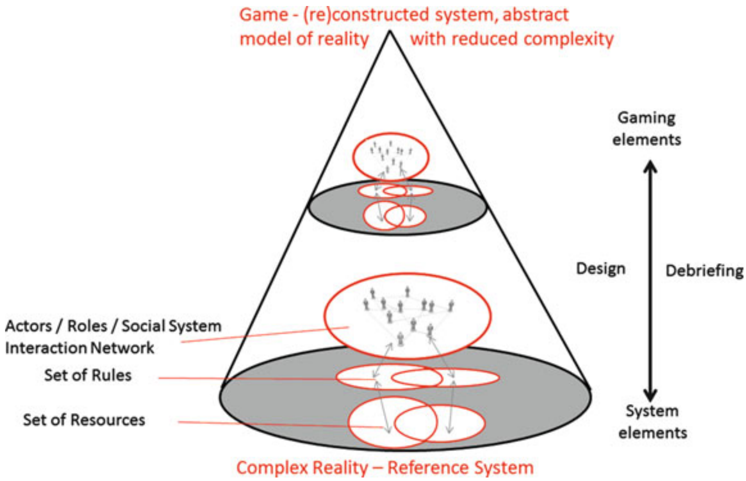

Fig. 1 Building blocks of games and real systems (based on Klabbers 2008; Duke 1974)

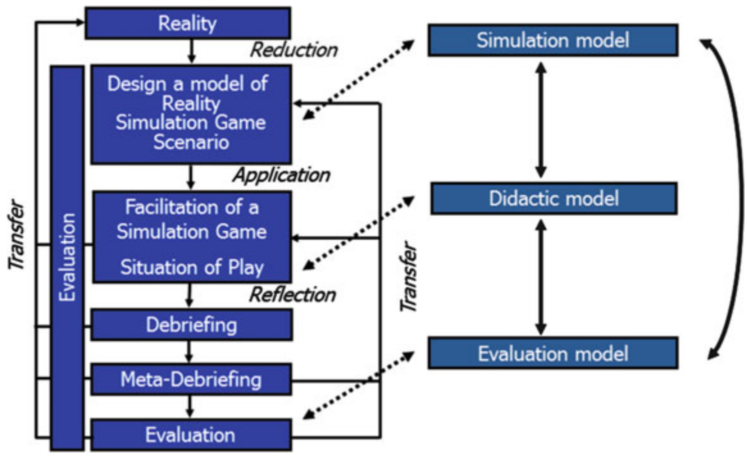

Fig. 2 Process of gaming simulation (based on Kriz 2003, 2012)

scenario) as a dynamic model of reality is created. In the design part of the process, a simulation model is created. This model defines the relationship between system elements and gaming elements.

The designed game is applied through facilitation. To play the game means to use a game artifact (*form*) to simulate (*function*) systems processes. Debriefing is conducted to enhance the learning process (see below) and to apply newly gained insights, knowledge, and skills within the design in the small aimed at changing reality, i.e., design in the large. In this part of the process, known as facilitation and debriefing, a didactic model is applied. This model defines how the game is used with a specific target group and within a specific context.

In the secondary phase of debriefing, referred to as meta-debriefing, an evaluation is required to encourage players to further reflect on the linkages between design in the small and design in the large and to measure profits of changes in reality. In this part of the process (evaluation), an evaluation model is defined. This model defines how the potential effects of the game are investigated and how and why the game works in given contexts of use (Hense and Kriz 2008).

By inviting stakeholders and opinion leaders to participate in the design process, their contributions as agents and actors are more naturally accepted. Participating in the design, play, and debriefing allows the players to take part in the design in the small process while ultimately contributing to the next phase of the social systems processes' design in the large.

3 Gaming Simulation and Learning

Learning experiences need to enhance learners' personal development as they gain the capacity to question the validity of acquired knowledge and develop a sensitivity toward social processes. Unlike situations of passive knowledge transfer, learners are drawn into an active, experience-based learning environment. The orientation is oriented toward the discovery of what is personally important (Kriz et al. 2014; Schwägele 2014). Simulation games enable self-organized or self-directed learning, based on one's active experience to nurture competencies and skills. The key principles are:

- Self-activation and learner activation (i.e., the autonomy of learners in designing their learning activities)
- Learner orientation (i.e., building on the learners' previous knowledge and experience and being guided by the learners' interests, e.g., arousing curiosity)
- Being close to real life (i.e., being oriented toward reality; a key idea is that thinking develops from taking practical action in realistic and authentic situations)
- Holism and purpose (i.e., enabling complete action sequences, the systemic observation of connections, and the integration of cognitive, affective, and psychomotor processes while learning) (Kriz 2010)

To support the acquisition of skills, simulation games provide practical and relevant learning environments with realistic complexity and scope for decision-making and action. Gaming simulation is an interactive and learning environment that makes it possible to cope with authentic situations that closely mimic reality. At the same time, it is a form of social learning because it challenges and provokes team-based problem solving.

The ability to make mistakes is necessary, especially when it comes to innovating and developing solutions to problems. All that needs to be ensured is that the consequences of the mistakes – desirable mistakes that teach lessons – do no harm. Simulation games represent so-called mistake-friendly environments and enable collaborative, cooperative trial action, i.e., the planning of action strategies as well as their execution and optimization.

Another advantage of simulation games is the immediate feedback of action effects; the accelerated pace of simulation also creates tangible long-term effects. Simulation games are thus experimental and experience-oriented learning environments. A single simulation game allows multiple contexts of use, and newly gained knowledge can be used to enter unfamiliar domains. This learning under multiple perspectives creates flexibility with domain-specific knowledge. Learning from multiple perspectives, as in gaming simulation, provides players with the intellectual tools they need to transform new knowledge into action. The major rationale for using gaming simulation is not only to define objectives and strategies for achieving learning goals but also to implement actions to achieve them. Furthermore, gaming simulation aims to diagnose, analyze, and assess responses to critical situations that occur and to make the consequences of decisions transparent.

Gaming simulation research shows that learning is enhanced above all by additional reflection and transfer modules during and after the simulation game (Kriz and Hense 2006; Auchter and Kriz 2014). "Debriefing" has become a widely accepted term for these processes of reflection and transfer. Key debriefing processes are game analysis (what happened? what did the players feel?), game reflection (how to explain the course of the game? how to evaluate the game result?), transfer (how are game and reality related? what aspects of the game were (un)realistic?), and learning effect (what did we learn? what decisions and solutions will I actually implement in my real-life, everyday work environment?) (Kriz 2010; Thiagarajan 1993).

Participants enhance their systems thinking and skills for understanding and changing systems through discussion of lessons learned and problem-solving strategies during the debriefing. Debriefing offers more time for players to share multiple perspectives and to construct common mental models through social interaction (Kriz and Brandstätter 2003).

Evaluation research has shown how simulation games create a motivating learning environment. The chosen methodology should inspire players to assume a role in the game. This is important; role-taking fosters long-term interest in the educational content of the simulation game and promotes the acquisition of knowledge (Kriz et al. 2008; Hense et al. 2009; Knogler and Lewalter 2014).

Learning with gaming simulation can include game design. In the case of "open games," the simulation model, rules, and the course of the game are not specified a priori. Instead, they are co-constructed by the participants with facilitation from seasoned simulation game designers. The participants thus become "experts" who construct systems and pedagogical models in the sense of a shared social representation of reality. This self-organizing learning environment not only shows the contextual nature of knowledge but also the connection between perspectives and changing contexts of knowledge (Klabbers 2008; Kriz et al. 2004).

4 Case Study: FHV University Curriculum on Systems Management Through Hybrid Gaming Simulation Design

The curriculum module is part of the so-called module library for the Master's degree programs at the FH Vorarlberg University in Austria. This innovative module library offers a total of more than 20 modules. In addition to the standard curriculum, students are free to choose several modules as part of their program at the beginning of their studies. In this way, they assume partial responsibility for their personal, academic path. Because of this approach, students of different programs are mixed in the module seminars. Students of business and management, media design, social studies, computer science, engineering, and so on broaden their horizons in interdisciplinary collaboration with students from other academic areas. No other Austrian universities offer students this opportunity. Each module consists of three consecutive seminars taught over consecutive semesters (duration of one and half year). Modules have nine ECTS credit points (ECTS = European Credit Transfer System), which ensures a minimum workload of 250 h. About 20–25 students participate in each module.

The main contents and objectives of the systems management through hybrid gaming simulation design module are fostering systems thinking (especially skills for analysis and sustainable development of complex system dynamics), fostering teamwork skills (especially training of competencies for better problem solving, decision-making, communication, and exchange of mental models in project teams), and learning about methods of gaming simulation. The titles of the three consecutive seminars are:

First semester: Fundamentals of Management with Systems Thinking
Second semester: Cause-and-Effect Diagrams, Simulation, and Modeling
Third semester: Hybrid Simulation and Gaming

In general, we follow an approach described by Klabbers in the 1970s. He argued that interactive gaming simulation is an integration of a computer simulation, human-computer simulation, and gaming. Klabbers also proposed a three-stage model of simulation game development (Klabbers et al. 1979, pp. 118–120):

- Stage 1: Development of a simulation model (with a focus on simulation and analysis of quantitative aspects of socio-technical systems)
- Stage 2: Embedding the simulation model in an interactive (computer-assisted or computer-simulated) simulation (with additional focus on more qualitative individual aspects of human behavior in coping with complex systems, strategy development, and decision-making)
- Stage 3: Embedding the interactive simulation in a game (with additional focus on group dynamics and communication in policy formation and organizational learning)

During Seminar I, students participate in different simulation games to gain basic skills in systems thinking and to learn about methods of gaming simulation (e.g., policy exercises, role-play, pure games, and experiential learning activities, simulation games, and played simulations, as well as computer simulations). In this seminar, teachers lecture on theory, present various techniques (e.g., tools for building models and systems analysis, brainstorming techniques, decision-making techniques, and debriefing methods), and run illustrative simulation games. Learning outcomes are that the students become acquainted with the fundamental principles of systems thinking and that they can analyze systems behavior in different disciplines and areas of application. Students learn how to create simple multi-relational feedback loop models of systems. Students learn in theory and practice about important factors for cooperation in interdisciplinary teams as they have to work together in mixed discipline teams with coaching by teachers. Students learn about systems archetypes (Kim 1994) and can analyze, predict, and display simple systems behavior and develop intervention strategies in systems. Lectures with discussions are held on different forms of systems theory (e.g., system dynamics, chaos theory, synergetics, cybernetics) and their application to management questions (Figs. 3, 4, and 5).

Exercises are conducted to learn about simple modeling techniques. For example, exercises are conducted on multi-relational cause-and-effect structures (feedback loop diagrams), behavior-over-time diagrams, graphical functions diagrams, policy structure diagrams, computer models, management flight simulators, and so

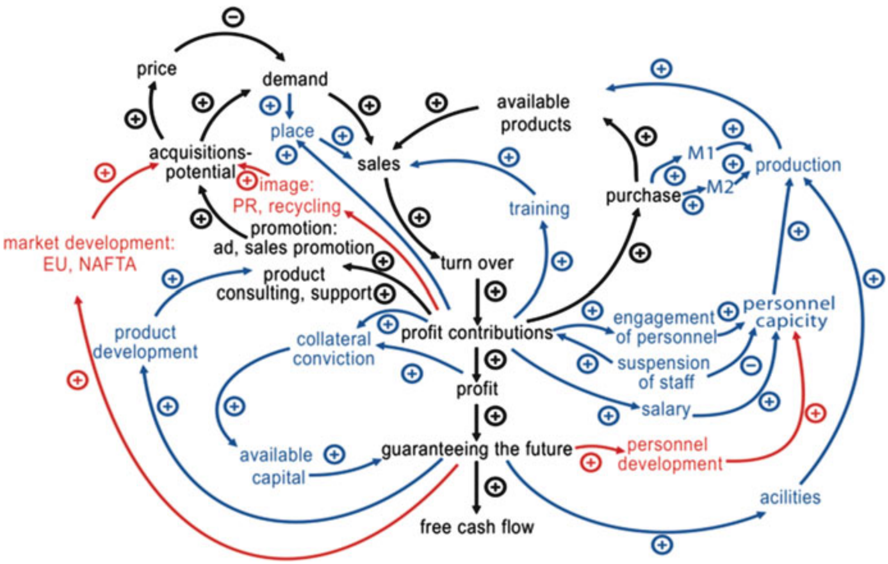

Fig. 3 Feedback loops diagram as the basis for the Visim business game

Fig. 4 Students develop and present simple system dynamic models

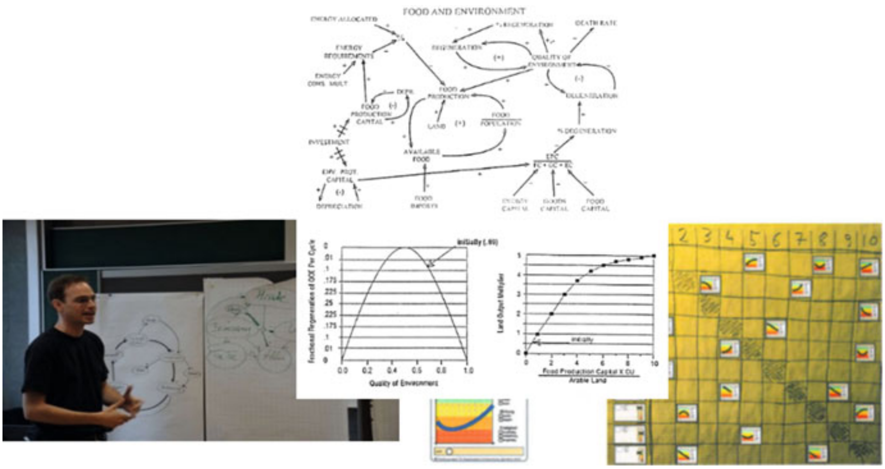

Fig. 5 Students playing Stratagem game; parts of Stratagem simulation model

on (Vennix 1996; Sterman 2000). The simulation games that are facilitated by the teachers are predominantly based on system dynamic models such as Ecopolicy by Frederic Vester (1994), Fish Banks and Stratagem by Dennis Meadows et al. (1993; Meadows and Toth 1985), and Visim by Thomas Maier (2011).

During Seminar II, the students work on real-life problems of real clients in small interdisciplinary project teams with coaching by their teachers. Students learn about advanced simulation methods of system dynamics and agent-based modeling. They start to build simulations and develop models with the support of different computer simulation software tools and use additional techniques like stakeholder analysis, balanced scorecard, and more. They learn about the simulation of scenarios, definition of adequate decision-making strategies for management, and the change of simulated and real complex and dynamic systems, as well as related practical problems of actual systems processes and structures (Fig. 6).

Although several researchers have proposed frameworks for the optimal design and structure of simulation games, Duke and Geurts (2004) proposed a total of five phases (and 21 steps). This is the approach we use most often in the university module. In Seminar II, we put the first two phases into practice. Students start with an initial, approximate clarification of the simulation game's objectives and target group. During this stage of problem clarification and problem formulation, project teams are formed and can introduce different perspectives and aspects of the problem. The teams then agree with real clients on the key questions ("defining the macro problem"). Systems analysis and model construction are next and include the selection of appropriate content and the analysis and definition of the systems and system elements to be simulated. The team discusses factors and elements that influence the problem to be solved or that interact with the system that is to be simulated. This serves to explore the problem environment and to integrate relevant factors and relationships into the model. Another key aspect is the graphic visualization of the system elements and their interrelationships through charts, schematics, and cause-and-effect diagrams. This visualization of the problem environment is also important because it shows the limitations of the simulation model. Based on the outcomes of different simulations and scenario techniques,

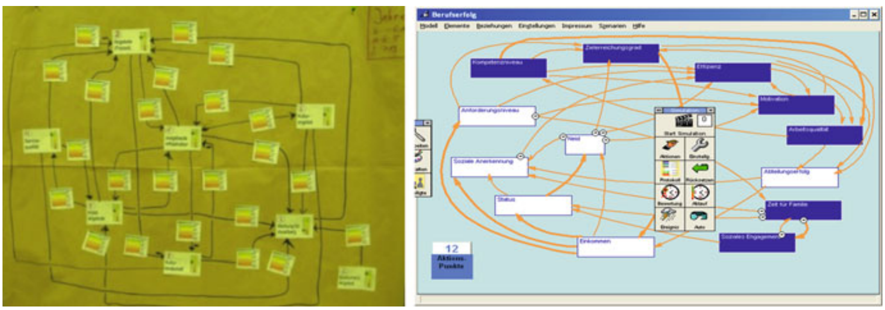

Fig. 6 Simulation models are transferred into computer simulation software, and different simulation approaches and scenario simulations are carried out

students learn to give decision-making recommendations to the client, as well as recommendations about how to change socio-technical systems.

During Seminar III, the participants remain in their teams and learn how to design simulation games. Self-created prototype games are presented, conducted, and tested. The teachers facilitate a continued meta-debriefing within the design process.

Since simulation is the only one aspect of a simulation game, a concrete game method has to be selected in Seminar III. Following the steps proposed by Duke and Geurts (2004), a blueprint is then created. The blueprint includes identifying both the actors and the concrete roles of the players. Teams must determine which actors are played and which are simulated in a different way (the game leader, e.g., can play several actors or represent them via computer simulation or event cards).

Rules need to be determined to define the players' scope for action and decision-making. Teams must also decide which resources the players can use during the simulation game, either concretely or symbolically, and how this will happen. Additionally, the chronological sequence (steps of play) of the simulation game needs to be considered. The accounting system must also be decided by the teams and should be used to record system changes and the course of the game. It is also possible to have simulation games that do not proceed via similar rounds of activity but as a sequence of continually novel scenarios or a combination of both approaches. The scenarios themselves also need to be defined.

Features of scenarios include specific starting situations (states of system elements), defined momentum of system elements, defined events that are to happen independently of players' decisions, and defined actions that can be triggered by players (e.g., by measures determined by decisions). Ultimately, all these necessary definitions feed into the development of a system components/gaming elements matrix; a systematic overview of the game structure that illustrates how the system components and interrelations are represented as gaming elements and their relations (gaming elements include rules, roles, events, and so on).

During the next step – the concrete development or building of the simulation game – a simulation game prototype is created, tested, and modified. Once again, many different aspects play a role, from assessing the adequacy of the model's contents, to the graphic design, to the technical evaluation. In the final analysis, it is about constantly optimizing the simulation game. Then, the finished simulation game is ready for use. The game is presented together with a game concept report Greenblat (1988), manuals, and a scientific paper that must be based on research in the subject area of the game (Fig. 7).

Fig. 7 Hybrid prototype simulation games are tested and presented

5 Conclusion

Designing a hybrid simulation game requires constructing a model of reality. Gaming simulation is a suitable method for making the interpretations and perspectives of the many different individuals contributing to the design process, including the client, visible. During the construction of a simulation model, it is possible to gain information about the social, but otherwise largely subconscious, construction of reality in a social system, which may be new for everyone involved. From a constructivist perspective, it is conceivable to have several different models of a reality segment represented in a simulation game, although none of the models may be capable of giving a full representation of reality. Priorities need to be set. Contradictory assumptions about reality are made explicit during the game development. Through the game design process, it is ultimately possible to create a tangible shared mental model.

The simulation game is based upon a solid systems analysis and tested simulation models. The design process is practice oriented because it deals with real-life problems of clients and offers support for their problem solving and decision-making. At the same time, the simulation game must be connected with research findings. In this way, students learn important skills for their future careers, for systems management with gaming simulation, and for scientific thinking. They specialize in the particularly interesting field of systems thinking, group model building, and gaming and attain qualifications relevant to their profession. Evaluation results of the module show that the students who have completed the program thus far were very satisfied with their learning experience.

References

Armstrong, R. (1995). Gaming-simulation in perspective. In D. Crookall & K. Arai (Eds.), *Simulation and gaming across disciplines and cultures. ISAGA at a watershed* (pp. 213–224). Thousand Oaks: Sage.

Auchter, E., & Kriz, W. C. (2014). The impact of business simulations as a teaching method on entrepreneurial competencies and motivation – a review of 10 years of evaluation research in entrepreneurship education. In W. C. Kriz (Ed.), *The shift from teaching to learning: Individual, collective and organizational learning through gaming & simulation* (pp. 187–197). Bielefeld: W. Bertelsmann Verlag.

Becker, H. A., & Goudappel, H. M. (Eds.). (1972). *Developments in simulation and gaming*. Utrecht: Utrecht University.

Deguchi, H. (2004). *Economics as an agent-based complex system. Toward agent-based social systems sciences*. Tokyo: Springer.

Duke, R. D. (1974). *Gaming: The future's language*. New York: Sage.

Duke, R. D., & Geurts, J. (2004). *Policy games for strategic management*. Amsterdam: Durch University Press.

Duke, R. D., & Kriz, W. C. (Eds.). (2014). *Back to the future of gaming*. Bielefeld: W. Bertelsmann Verlag.

Fischer, M., & Barnabé, F. (2009). Microworld development. *Simulation & Gaming, 40*(1), 85–97.

Greenblat, C. S. (1988). *Designing games and simulations*. Beverly Hills: Sage.

Hense, J., & Kriz, W. C. (2008). Making simulation games an even more powerful tool. Introducing the theory-based evaluation approach. In L. de Caluwé, G. J. Hofstede, & V. Peters (Eds.), *Why do games work? In search for the active substance* (pp. 211–217). Deventer: Kluver.

Hense, J., Kriz, W. C., & Wolfe, J. (2009). Putting theory oriented evaluation in practice: A logic model approach for the evaluation of Simgame. *Simulation & Gaming, 40*(1), 110–133.

Kaneda, T. (2012). On a formalization of agent-based social systems – as a common basis for modeling gaming simulation and agent-based social simulation. *Japan Journal of Gaming Simulation, 22*, 5–15.

Kikkawa, T. (2014). Gaming as the futures language case studies and development. In R. D. Duke & W. C. Kriz (Eds.), *Back to the future of gaming* (pp. 93–99). Bielefeld: W. Bertelsmann Verlag.

Kim, D. H. (1994). *Systems archetypes*. Boston: Pegasus Communications.

Klabbers, J. (1989). On the improvement of competence. In J. Klabbers (Ed.), *Proceedings of the ISAGA 19th conference 1988* (pp. 3–8). New York: Pergamon Press.

Klabbers, J. (1999). Three easy pieces: A taxonomy on gaming. In D. Sounders & J. Severn (Eds.), *Simulation & gaming yearbook vol. 7. Simulation and games for strategy and policy planning* (pp. 16–33). London: Kogan Page.

Klabbers, J. (2006). A framework for artifact assessment and theory testing. *Simulation & Gaming, 37*(2), 155–173.

Klabbers, J. (2008). *The magic circle: Principles of gaming & simulation*. Rotterdam: Sense Publishers.

Klabbers, J. (2014). Social problem solving: Beyond method. In R. D. Duke & W. C. Kriz (Eds.), *Back to the future of gaming* (pp. 12–29). Bielefeld: W. Bertelsmann Verlag.

Klabbers, J., van der Hijden, P., Hoefnagels, K., & Truin, G. (1979). Development of an interactive Simulation/game: A case study of the development of DENTIST. In K. Bruin, J. de Haan, C. Teijken, & W. Veeman (Eds.), *How to build a simulation/game*. Proceedings of the 10th ISAGA conference (pp. 113–145). Leeuwarden: University Groningen.

Knogler, M., & Lewalter, D. (2014). What makes simulation games motivating? Design based research on learners' motivation in simulation games. In W. C. Kriz (Ed.), *The shift from teaching to learning: Individual, collective and organizational learning through gaming & simulation* (pp. 150–162). Bielefeld: W. Bertelsmann Verlag.

Kriz, W. C. (2003). Creating effective interactive learning environments through gaming simulation design. *Simulation & Gaming, 34*(4), 495–511.

Kriz, W. C. (2010). A systems-oriented constructivism approach to the facilitation and debriefing of simulations and games. *Simulation & Gaming, 41*(5), 663–680.

Kriz, W. C. (2012). Gaming simulation and ethics: Reflection on interconnections and implications. *Japan Journal of Gaming Simulation, 22*, 65–68.

Kriz, W.C., & Brandstätter, E. (2003). Evaluation of a training program for systems-thinking and teamwork-skills with gaming and simulation. In F. Percival, H. Godfrey, P. Laybourn, & S. Murray (Eds.), *The international simulation and gaming research yearbook. Volume 11. Interactive learning through gaming and simulation* (pp. 243–247). Edinburgh: Edinburgh University Press.

Kriz, W. C., & Hense, J. (2006). Theory-oriented evaluation for the design of and research in gaming and simulation. *Simulation & Gaming, 37*(2), 268–283.

Kriz, W. C., Puschert, M., Karl, J., & Dufter-Weis, A. (2004). Effective learning through gaming simulation design. In R. Shiratori, K. Arai, & F. Kato (Eds.), *Gaming, simulations and society* (pp. 217–227). Tokyo: Springer.

Kriz, W. C., Auchter, E., & Wittenzellner, H. (2008). Theory-based evaluation of entrepreneurship education with simulation games. *Indian Journal of Economics and Business, 2008*, 19–33.

Kriz, W.C., Eiselen, E., & Manahl, W. (Eds.). (2014). *The shift from teaching to learning. Individual, collective and organizational learning through gaming simulation.* In Proceedings of the 45th conference of the international simulation and gaming association. Bielefeld: W. Bertelsmann Verlag.

Maier, T. (2011). *ViSim 8.0 Unternehmenssimulation*. St Gallen: Incon.

Meadows, D., & Toth, F. (1985). *Stratagem-1.A. Microcomputer based management training game on the dynamics of energy/environment interaction*. Durham: University of New Hampshire.

Meadows, D. L., Fiddamann, T., & Shannon, D. (1993). *Fish Banks, Ltd. Laboratory for interactive learning. Institute for policy and social science research*. Durham: University of New Hampshire.

Meijer, S., Reich, Y., & Subrahmanian, E. (2014). The future of gaming for design of complex systems. In R. D. Duke & W. C. Kriz (Eds.), *Back to the future of gaming* (pp. 154–167). Bielefeld: W. Bertelsmann Verlag.

Rizzi, P. (2014). Between no-place and no-time. In R. D. Duke & W. C. Kriz (Eds.), *Back to the future of gaming* (pp. 59–65). Bielefeld: W. Bertelsmann Verlag.

Schwägele, S. (2014). Gaming – an environment for learning and transfer. In R. D. Duke & W. C. Kriz (Eds.), *Back to the future of gaming* (pp. 242–255). Bielefeld: W. Bertelsmann Verlag.

Senge, P. M. (1990). *The fifth discipline. The art and practice of the learning organization*. New York: Currency Doubleday.

Sterman, J. D. (2000). *Business dynamics. Systems thinking and modeling for a complex world*. New York: McGraw-Hill.

Thiagarajan, S. (1993). How to maximize transfer from simulation games through systematic debriefing. In F. Percival, S. Lodge, & D. Saunders (Eds.), *The simulation and gaming yearbook 1993* (pp. 45–52). London: Kogan Page.

Tsuchiya, S. (2012). Policy exercise for organizational transformation: A double-loop learning perspective. *Japan Journal of Gaming Simulation, 22*, 69–76.

Vennix, A. M. J. (1996). *Group model building. Facilitating team learning using system dynamics*. Chichester: Wiley.

Vester, F. (1994). *Ecopolicy®* – Computerspiel als englische DOS-Version von Ökolopoly, Studiengruppe für Biologie und Umwelt, Frederic Vester GmbH.

Simulation and Gaming in Virtual Language Learning Literacy

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Abstract The CoMoViWo project, financed by the European Union's Education, Audiovisual and Culture Executive Agency (EACEA), aims to improve the employability of graduates and professionals by developing literacy training for virtual communication. The innovative aspect of this project is the fusion of communication, technology, and multiculturality in association with business enterprises. The present study centers on detecting the specific needs for virtual communication and mobility in the workplace by means of a descriptive analysis studying work context of 102 employees using virtual communication and a qualitative analysis based on the opinions of nine linguists, experts in the field of simulation and gaming, which brings to the foreground characteristics that games or simulations should provide, as well as the importance of effective virtual debriefing, if used in online literacy. After the fieldwork is carried out, the results obtained provide the necessary feedback for orienting the materials designers to take into account the multiple applications of simulation and gaming. The development of a series of intensive modules for improving foreign language use in virtual and mobile contexts in the workplace is the ultimate objective of the present project.

Keywords Simulation and gaming • Virtual communication • Virtual debriefing • Technology • Multiculturality

1 Simulation and Gaming in Virtual Language Learning Literacy

The current academic and labor context forces professionals in the education sector to research on appropriate forms of training that are versatile and facilitate effective communication in a second language in virtual work environments and labor mobility. Most companies immersed in a workflow that takes them beyond the

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group at local and international levels or for networking have these communication needs (Waldeck et al. 2012). Lam et al. (2014) define this new work context as volatile, intercultural, and multilingual.

In this framework, the project CoMoViWo (Communication in Mobile and Virtual Work), funded by the Education Audiovisual and Culture Executive Agency (EACEA) of the European Union, has been set up with the fundamental objective of improving the employability of graduates and professionals, connecting active staff through virtual media language literacy training.

By means of descriptive and qualitative analysis concerning the views of 102 employees and nine experts in simulation and gaming, the present paper aims to detect the language needs of employees using virtual communication in the workplace. Likewise, the study also examines whether simulations and games are valid tools to consider adopting in the design of virtual training modules, as well as effective virtual debriefing. The latest research on teaching languages in the workplace according to Newton and Kuśmierczyk (2011) focuses on communication skills in the English language, sociopragmatic skills, and ability to communicate in different contexts within an ever more globalized world. Research also highlights interpersonal and informal communication in the workplace as well as engagement with other cultures. It is thought, thus, that sociopragmatic instruction can be addressed by identifying pragmatic resources in interactions or by simulation and gaming (Pérez-Sabater and Montero Fleta 2014; García-Carbonell et al. 2014). In this way, language training of employees should be centered on the language required in the workplace rather than general language training.

The new models of communication involve new ways to write, speak, and understand virtually. Duff (2008) sees implications of these changes in language and communication between enterprises, globalization, migration, and market pressure and notes that these parameters are associated with the development of new forms of literacy, a new awareness of sociolinguistic and cultural aspects of communication and different expectations about learning and language use. Tools such as shared platforms, instant messaging, conferencing, email, or social networks enable virtual group work anytime and anywhere, as noted by Jones and Hafner (2012). Thus, research on language in virtual communication in the workplace will have to take into account these new features that characterize the context of current work and new discursive practices.

Consequently, in order to help future professionals to interact more efficiently in the workplace, students should acquire skills and attitudes that enable the development of professional skills such as cooperation among employees and management teams, mutual understanding, negotiation, and co-planning (Duff 2005; Yates and Springall 2010; Halvorsen 2013; García-Carbonell et al. 2014; Pérez-Sabater and Montero Fleta 2014). Both simulation and gaming have shown in several studies to help not only with language learning per se but also with promoting intercultural awareness (Crookall and Arai 1995; Oxford et al. 1989; Ekker and Sutherland 2009; Sutherland and Ekker 2010) and pragmatic and interactional aspects in intercultural communication (MacDonald and Perry 2009; García-Carbonell and Watts 2012).

In short, CoMoViWo defines the needs of employers and employees who use communication in virtual contexts and labor mobility. For this purpose, sociolinguistic innovation is aimed at through the design of virtual training modules for higher education and postgraduate students and company staff.

2 Participants and Materials

The framework for the present study is the CoMoViWo project which is coordinated by the Turku University of Applied Sciences (TUAS) in Finland and includes the following institutions:

- International Certificate Conference V. (ICC) (Germany)
- The Manchester Metropolitan University (United Kingdom)
- Politechnika Gdansk (Poland)
- Universitat Politècnica de València (Spain)

The project benefits from the collaboration with two companies, as partners, for each participating institution. These companies operate locally, nationally, and internationally, both in the public and private sectors, and contribute at different stages of the project, with the final task of dissemination and exploitation of the project.

Other participants in this phase of the project include 102 employees of different companies performing nationally and internationally. An online multiple choice questionnaire consisting of 30 questions organized in four sections is addressed to those employees.

In addition, there is an open-ended question addressed to experts in simulation and gaming and in foreign language training.

3 Methodology

The methodology used in the first and second phases of CoMoViWo project mirrors to a certain extent the ten-stage pattern set by Onwuegbuzie et al. (2010) and is shown in Fig. 1. The first five steps have already been carried out and have been presented in different international congresses.

The sixth step focuses, on the one hand, on a field study with 102 employees giving feedback through an online questionnaire concerning their day-to-day use of virtual communication in the workplace. The questionnaire used in the field test firstly collects personal data such as age; gender; mother tongue; labor sector; type of institution (whether private or public, national or international); company size; and job description. There is a second block of questions about virtual communication platforms, for instance, whether these are in English or in the respondent's native language; how, when, and under what conditions work platforms are used for

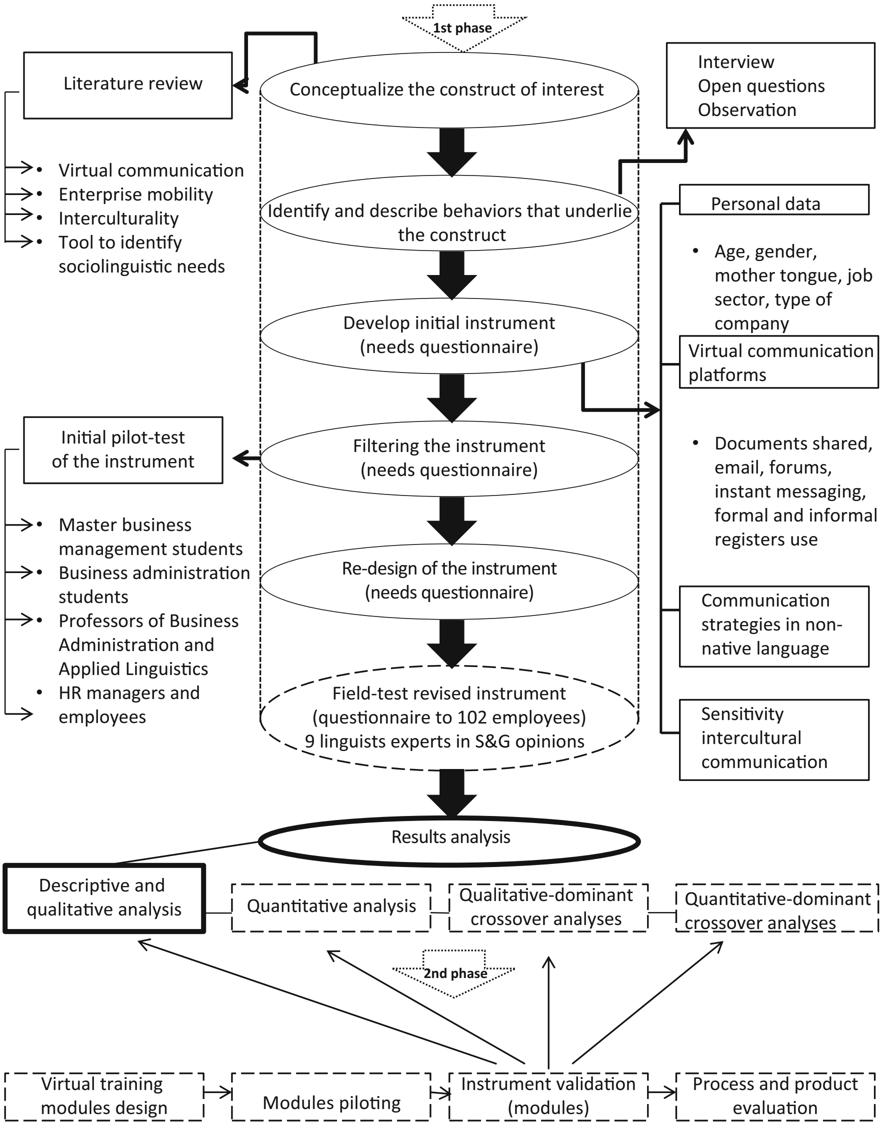

Fig. 1 Methodology of the first and second phase of the CoMoViWo Project

document sharing, email, forums, instant messaging, social networking, or teleconferencing. The use of formal and informal registers of language and the kind of platform on which they are used conform another aspect included in this block of items. A third section investigates the communication strategies necessary when the mother tongue is not being used. A fourth and final block enquires about intercultural awareness in communication at work.

On the other hand, the qualitative analysis is based on the responses to an open-ended question addressed to nine linguists, experts in simulation and gaming, about the appropriateness of games or simulations in virtual training of a foreign language. The study of the subjects' opinions followed the protocol for grounded theory set out in Charmaz (2006:11) in which responses are first coded and then sorted into preliminary categories until the data is saturated and subsequently analyzed in order to select the central conceptual categories that give rise to the results. To analyze data, ATLAS.Ti version 5.2 is used.

4 Results and Discussion

4.1 Descriptive Analysis

The descriptive analysis of the responses of 102 employees yields information that facilitates the profiling of the language needs of employees whose work environments involve the use of virtual communication as an everyday occurrence.

Of a total of 102 respondents, about 90 % are aged between 31 and 60 years. Forty-five percent of respondents are women, and 55 % are men. Although the questionnaire was distributed in two multinational and one national enterprise, 80 % of respondents have Spanish as mother tongue.

Regarding the three main types of work sector that respondents belong to, 32 % are in manufacturing; 15 % are in agriculture, forestry, and fishing; and 12 % are in information and communication. Of the companies participating in the survey, 80 % mainly develop their professional activity internationally, while 20 % do so nationally. It is noteworthy that 70 % of respondents work in large companies with more than 250 people. All this data shows that the majority of respondents work in big companies that interact internationally, which implies the use of different languages and where virtual and intercultural communication occurs regularly.

Regarding the use of online communication tools at work in English, as can be seen in Table 1, 75.7 % use email on a regular basis, i.e., frequently or always. At the opposite end of the scale, only 13.3 % use social networking. The results are similar when dealing with communication among virtual teams.

When asked about whether the employees' companies had norms related to political correctness, 42 % confirmed they did, 20 % said they did not, and a total of 32 % were unaware of any norms in their workplace. Of the respondents who do have political correctness norms at work (see Table 2), 44 % frequently or always use them. Turning to the register used in virtual communication, 41 % respond that they use formal English in the workplace either frequently or always, while 31.5 % interact in English in an informal way.

As can be observed in Fig. 2, a total of 70 % feel that their handling of negotiations in English requires more strategy training in order to improve their

Table 1 Virtual communication in English at the workplace

	Never	Occasionally	Sometimes	Frequently	Always
Document sharing platforms	10 %	12 %	26 %	21 %	31 %
Email	1.9 %	5.6 %	16.8 %	14 %	61.7 %
Forum	22.5 %	18.3 %	33.7 %	13.3 %	12.2 %
Instant messaging	11.3 %	11.6 %	22.7 %	29.7 %	24.7 %
Social networking	40.8 %	22.4 %	23.5 %	9.1 %	4.2 %
Teleconferencing	10.6 %	10 %	33.6 %	19.8 %	26 %

Table 2 Political correctness and register in virtual communication in English at the workplace

	Never	Occasionally	Sometimes	Frequently	Always
Use of norms of political correctness when communicating in English virtually	16 %	10 %	9.5 %	12 %	32 %
Communicate in English formally in virtual work	15 %	18.5 %	20 %	21 %	20 %
Communicate in English informally in virtual work	17 %	29 %	23 %	16.5 %	15 %

skills and therefore the outcome of the negotiation process. Negotiating in a foreign language involves not only knowing the language itself, but it also requires an awareness of certain pragmatic and intercultural conventions that are not necessarily triggered automatically by language users. In a close second place, the employees surveyed commented on the need to improve their conversation skills, especially as regard carrying out small talk and opening and closing conversation.

Nearly half of the respondents felt they needed to improve their skills for giving virtual presentations and in fourth and fifth place the aspects that respondents declared needed attention concern the handling of requests and refusals and managing or hosting virtual group interactions with 46 % and 44 %, respectively.

Another important aspect which the survey aimed to find out more about is the awareness employees have, when communicating in English virtually, of other cultures and their religious beliefs. Table 3 reveals that on the whole, the respondents are aware of and have a tolerant attitude to interlocutors from different cultural contexts.

Over 70 % say they are frequently or always conscious of the other's cultural values which may be different from their own.

In the same way, 90 % of respondents (sometimes, frequently or always) declare they do not tend to pass judgment on people from different cultures who act in a different way to the in-group, i.e., the respondent's own culture. The great majority (93 %) adjust their communication strategies either sometimes, frequently, or always, when interacting virtually with people from cultures they are not familiar with.

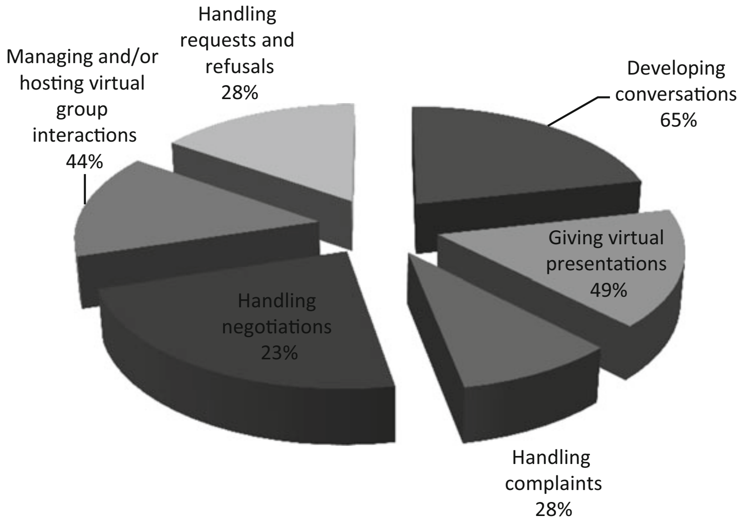

Fig. 2 Strategies needed to develop when communicating virtually

Table 3 Intercultural communication at work

	Never	Occasionally	Sometimes	Frequently	Always
I am aware of the cultural values and religious beliefs with people from different cultures	5.2 %	6.4 %	15.4 %	36 %	37 %
I try not to judge people when their behavior or customs are different from mine	5.8 %	4.7 %	12.8 %	36.9 %	39.8 %
I adjust my communication strategies (e.g., speak more slowly, use simplified language) when I interact in virtual settings with people from a culture that is unfamiliar to me	1.3 %	5.6 %	23 %	41.6 %	28.5 %

4.2 *Qualitative Analysis*

The qualitative analysis investigated the responses from nine experts in simulation and gaming and language teaching to the following open question: Please express your opinion about the characteristics and debriefing of games and simulations to be used in virtual language learning literacy. Analysis of the coded data first brought into focus four preliminary categories extracted from the experts' comments on the kind of games or simulations appropriate for virtual teaching of a foreign language: the features of games or simulations to be effective in virtual language teaching and the effectiveness of virtual debriefing and effectiveness of debriefing in virtual teaching. Closer scrutiny yielded two central categories related to (1) games and simulations for virtual teaching of a foreign language and (2) virtual debriefing in virtual teaching. The extracts from the experts' comments are identified by the letter E along with the number of the author of the comment.

4.2.1 Games and Simulations for Virtual Teaching of a Foreign Language

In the first place, the simulation and/or game should be computer assisted rather than computer based and should be appropriately chosen for developing language skills and for activating cognitive knowledge, not focusing exclusively on recall or identification but including other levels of knowledge. They should also be planned so that they are relevant to the language needs of the learners, although the goals may be achieved through creating fantasy or fictional worlds:

> *Games/simulations that have the user generate responses that require language would be appropriate, as well as those that call into play different levels of knowledge, not only recall or identification.* (E4)
>
> *They must be relevant to the language needs of the learners. The game itself could be an adventure or even fantasy but the language should appeal to the learners and help them in their communication needs.* (E9)

Motivation is another important aspect mentioned by the experts. In order to motivate learners, they should feel that the task is authentic and especially with simulations; the different phases should be well explained beforehand. It is essential that they perceive there is a real need to communicate while interacting both online and offline.

> *Learning objectives, instructions to the learner and other information ahead of the action phase of a game or simulation is very important and should be considered an integral component of the lesson plan in which the game or simulation is inserted.... (E4)*

According to the panel of experts, if learning goals are clearly outlined, the outcomes are usually evaluated in a positive way by the participants:

> *My experience says that students found the use of games and simulations in virtual training makes the process easier, effective and satisfying.... (E1)*
>
> *Games and simulations need to be attractive.... (E2) ...my students always wanted to "work" longer and harder if they were involved in the simulation. (E9)*
>
> *... any games that have clear learning goals, and that allow the learner to reach the determined goals... learners must perceive the game to be useful --- also need to do proper debriefing!! (E6)*

4.2.2 Virtual Debriefing in Virtual Teaching

Virtual debriefing should be more than just writing a list of successes and failures and checking for language errors. Indeed, it is important not to overlook the relevance of this vital phase in an online literacy training course:

Debriefing simulations and games in online environments has not received enough attention considering the significance for learning. (E5)

Debriefing games and simulations and relating insights from debriefing to professional practice should be a challenge in virtual literacy. (E1)

As one expert pointed out, technology-enhanced communication should be used for interactive virtual debriefing:

Simulations and games in virtual literacy are not easy to debrief. Technology may help, but interaction between participants and trainers is essential to reach learning goals. (E9) . . . but briefing and debriefing using a videoconference, skype, a forum or a chat should take place. (E2)

Debriefing should prompt participants to become actively engaged in exploring their feelings and reflecting on both the product/outcomes and the processes involved in the different phases:

In virtual learning, games need to be even more debriefed -- with regular in-game short debriefing sessions, focusing both on language and on substance and process. (E6)

Debriefing should be prepared in advance because spontaneous questions do not necessarily enhance learning. Feedback has to become systematized, and the experts consulted point to ways this can come about in virtual learning environments:

Virtual debriefing can be effective. Debriefing can be guided by questions that students have to answer. A combination of self- peer and teacher assessment can be used, depending on the breadth and depth of the game or simulation. A virtual debriefing plenary session might suffice but should be prepared... Spontaneous questioning might not yield all the benefits that debriefing should yield in consolidating learning. (E4)

All experts conclude that virtual debriefing can be effective as long as it is well prepared and interactive. Also, debriefing can be successful if psychological and cognitive aspects involved in learning are addressed.

5 Conclusion

The ongoing project CoMoViWo aims, in the long term, to develop learning modules for improving virtual communication skills in the workplace. The initial stage has involved carrying out a needs analysis of the employees in both multinational and local businesses with a view to establishing the use of different virtual communication tools for inter- and intracompany matters, formal and informal registers online, political correctness within companies, and finally identifying current practices related to intercultural awareness. Results show that both individually and working in virtual teams, email, videoconferencing, and document sharing platforms are the most used communication tools, and when using these, formal registers are used virtually more than informal registers. There is a general tendency to actively apply the norms of political correctness in the companies that do actually have them. There was also an apparent awareness and respect for the cultural values and beliefs of others and willingness to adjust communication strategies in order to bridge the gap when communicating across cultures. The aspects that the employees themselves thought most needed improvement for virtual communication in the workplace centered on negotiating skills, conversation, giving presentations, and handling requests and refusals which, to a greater or lesser extent, are related to the development of pragmalinguistic competence. It is thought that simulation and games could contribute in a positive way to developing the skills required for successful virtual communication in the workplace.

When using simulation and gaming in virtual literacy, participation of instructors and students in debriefing is indispensable, although some experts point out that deferred debriefing, if well planned, could be effective. Whatever the case, both synchronous and asynchronous debriefings need a conducting facilitator. In order to ensure engagement, virtual debriefing should be in-depth and facilitated by computer-assisted sessions. Moreover, individual and collective engagement is necessary in computer-based debriefing since participants should not only reflect on the outcome of the simulation itself but also on the whole process they have all been actively involved in. If engagement in debriefing is as important as engagement in game playing, it is worthy of more attention and research (Crookall 2014) especially with reference to virtual debriefing.

References

Charmaz, K. (2006). *Constructing grounded theory. A practical guide through qualitative analysis*. London: Sage.

CoMoViWo. Application form. Call: 2014. KA2 – Cooperation and innovation for good practices. 2014-1-F101-KA203-000851

Crookall, D., & Arai, K. (1995). Preface: Interdisciplinarity and interculturality. In D. Crookall & K. Arai (Eds.), *Simulation and gaming across disciplines and cultures: ISAGA at a watershed* (pp. xi–xxi). Thousand Oaks: Sage.

Crookall, D. (2014). Engaging (in) gameplay and (in) debriefing. *Simulation & Gaming, 45*(4–5), 416–427.

Duff, P. A. (2005). Thinking globally about new literacies: Multilingual socialization at work. In J. Anderson, M. Kendrick, T. Rodgers, & S. Smythe (Eds.), *Portraits of literacy across families, communities, and schools* (pp. 341–362). Mahwah: Erlbaum. Halvorsen.

Duff, P. A. (2008). Language socialization, higher education and work. In P. A. Duff & N. H. Hornberger (Eds.), *Encyclopedia of language and education* (Vol. 8, pp. 257–270). Boston: Springer.

Ekker, K., & Sutherland, J. (2009). Simulation game as a learning experience: An analysis of learning style. In D. Kinshuk, G. Sampson, J. M. Spector, P. Isaías, & D. Ifenthaler (Eds.), *Cognition and Exploratory Learning in Digital Age (CELDA 2009)*. Rome: IADIS Press.

García-Carbonell, A., & Watts, F. (2012). Investigación empírica del aprendizaje con simulación telemática. *Revista Iberoamericana de Educación, 59*(3), 1–11.

García-Carbonell, A., Andreu-Andrés, M. A., & Watts, F. (2014). Simulation and gaming as the future's language of language learning and acquisition of professional competences. In R. D. Duke & W. Kriz (Eds.), *Back to the future of gaming* (pp. 214–227). Germany: WB Verlag.

Halvorsen, K. (2013). Team decision making in the workplace: A systematic review of discourse analytic studies. *Journal of Applied Linguistics and Professional Practice, 7*(3), 273–296.

Jones, R. H., & Hafner, C. A. (2012). *Understanding digital literacies: A practical introduction*. London: Routledge.

Lam, P. W., Cheng, W., & Kong, K. C. (2014). Learning English through workplace communication: An evaluation of existing resources in Hong Kong. *English for Specific Purposes, 34*, 68–78.

MacDonald, P., & Perry, D. (2009). How engineering undergraduates can develop communication skills in English: An analysis of the structural and interactional aspects of teleconferences in the IDEELS telematics simulation project. In R. Roy (Ed.), *Engineering education: Perspectives, issues and concerns* (pp. 366–380). Delhi: Shipra Publications.

Newton, J., & Kusmierczyk, E. (2011). Teaching second languages for the workplace. *Annual Review of Applied Linguistics, 31*, 74–92.

Onwuegbuzie, A. J., Collins, K. M. T., & Leech, N. L. (2010). *Mixed research: A step-by-step guide*. New York: Taylor & Francis.

Oxford, R. L., Lavine, R. Z., & Crookall, D. (1989). Language learning strategies, the communicative approach, and their classroom implications. *Foreign Language Annals, 22*, 29–39.

Pérez-Sabater, C., & Montero-Fleta, B. (2014). Pragmatic competence and social power awareness: The case of written and spoken discourse in non-native English environments. *International Journal of English Studies, 14*(2), 21–38.

Sutherland, J., & Ekker, K. (2010). Simulation – games as a learning experience: An analysis of learning style and attitude. In D. Ifenthaler, J. M. Spector, Kinshuk, P. Isaias, & D. G. Sampson (Eds.), *Multiple perspectives on problem solving and learning in the digital age*. New York: Springer.

Waldeck, J., Durante, C., Helmuth, B., & Marcia, B. (2012). Communication in a changing world: Contemporary perspectives on business communication competence. *Journal of Education for Business, 87*(4), 230–240.

Yates, L., & Springall, J. (2010). Soften up! Successful results in the workplace. In D. Tatsuki & N. Houck (Eds.), *Pragmatics from research to practice: Teaching speech acts* (pp. 67–86). Alexandria: Tesol.

Comparing Live-Action and Computer-Mediated Educational Games for Engineering Studies

Alexey Fedoseev

Abstract This paper is dedicated to the educational games designed for engineering studies. Following the actual requirements, these STEM games reproduce engineering activity that implies teamwork and solving engineering problems. Using the activity theory framework for the game design and the man-machine interaction research, we compare the differences in running the educational games in live-action and computer-mediated (computer-based and computer-assisted) formats. The analysis of the two real cases shows some limitations of multiplayer computer-based educational games with engineering agenda.

1 Introduction

Engineering education is changing rapidly together with the world of technologies and the whole society (Crawley et al. 2007; Rugarcia et al. 2000; ICOSE 2014). There are self-evident new requirements for competences of graduated engineers like "teamwork", "communication skills" or "system thinking" described in the new educational standards like CDIO (Crawley 2001).

Simulations and games[1] are considered as effective methods of teaching competences and "soft skills" by many authors (Crookall et al. 1987; Klabbers 2006; Whitton 2009; Wills et al. 2011). There are different approaches of using games and simulations in engineering education (Mayo 2007; Oliveira et al. 2014). Moreover, STEM games[2] become a popular and encouraging educational technology (Mayo 2009).

[1] In this paper we will not draw a distinction between games and simulations. The reason is that we will consider only the serious games specially designed for the educational purposes, with the significant modelling component. In these cases the difference between games and simulations blurs. One can find the good classification of models, games and simulations in (Crookall et al. 1987).

[2] STEM is an acronym for science, technology, engineering and math.

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Creating educational games implies the complex choice of technologies even if we consider only the digital medium (e.g. Prensky 2005). It is beneficial to use digital or computer-mediated formats of educational games for many reasons. Firstly, we often hear that schoolchildren understand modern technology much better than their teachers do and parents do; it is their “natural” environment (Tapscott 1998; Prensky 2001; Palfrey and Gasser 2013). Secondly, the popular online games can inspire real organizations to become playful organizations through playing and learning (Warmelink 2013). Moreover, digital and especially online technologies are extremely scalable and easy to run in a modern school. Finally, there is a big market of computer games we as designers can base on. At the same time, there are many live-action or hybrid formats of educational games or simulations that can be used in the STEM fields (e.g. Fedoseev and Vdovenko 2014).

Several authors (Crookall et al. 1986; Becu et al. 2014) have studied the learning impact and problems of such hybrid formats of educational games and simulations.

Crookall et al. (1986) introduce the model of human-computer interaction within computer-related simulations. The CS grid describes the four types of such simulations (see Fig. 1):

- Computer-assisted simulation (CAS) – users play human roles in the simulation; the decisions are made away from computer, and the computer is used as an additional tool.
- Computer-based simulation (CBS) – a user (or users) continually interacts with the computer as the simulation proceeds (e.g. flying simulation).
- Computer-controlled simulation (CCS) – computer controls the simulation but the players interact with each other to make decisions.
- Computer-dependent simulation (CDS) – pure computer simulation, very high level of computer-player interaction.

	Player-to-computer interaction prevails	Player-to-player interaction prevails
Players control the simulation	**Computer-based simulations (CBS)**	**Computer-assisted simulations (CAS)**
Computer controls the simulation	**Computer-dependent simulations (CDS)**	**Computer-controlled simulations (CCS)**

Fig. 1 The CS grid model (Crookall et al. 1986)

Crookall et al. (1986) state

> The CAS is the form of CS that most effectively encourages experimental learning when the objectives are the human and social aspects of the field study. . . . In terms of learning possibilities, the CAS will have greater scope and potential than other types when social and socially-mediated processes and skills are seen as important learning outcomes.

Another group of authors (Becu et al. 2014) highlights the advantages of the agent-based simulation formats based on role-playing games and human-to-human interaction and especially the hybrid simulations.

In this paper, we will extend the described models. We will try to find the new directions for the research of learning outcomes for hybrid educational games. We will take into consideration our experience of creating and running STEM games in 2013–2015 using the activity theory approach.

2 Activity Theory Approach for Education and Man-Machine Research

The activity theory and the cultural-historical approach in psychology were firstly introduced by soviet philosophers and psychologists (Vygotsky 1986; Leontiev 1978; Luria 1976; Elkonin 2005). Some of these results were extended by western authors (Engeström 2001: Nardi 1996), but many other researches of Vygotsky's heirs are still available only in Russian (Davydov 1999; Schedrovitsky, Gromyko 2000). The main concept of this theory is "activity". In this philosophic approach, activity is not a peculiarity of a person, but a social system of knowledge, rules, values and cultural patterns. This means that a person does not make an activity, quite the contrary, the activity embraces the person (Kaptelinin 2006). We will consider the modern implication of Vygotsky's activity theory – *thought-activity pedagogics* (Shchedrovitsky 1968; Gromyko 2000) – which allows designing the learning scenarios to engage the processes of internalization and externalization of cultural artefacts, tools and methods through the collective experience and reflection.

An educational game designed within the activity theory framework (Fedoseev and Vdovenko 2014) consists of these stages for players and game organizers (see Fig. 2).

The main stages of playing educational game are the briefing (introducing rules, models, roles etc.), the game itself (players make decisions and gain the experience) and the debriefing (the reflection process required for the reconstruction of the activity and highlighting the ways of acting and cultural artefacts required to solve the in-game tasks). At the same time, the organizers have to conduct simultaneously two processes: managing the model, the group dynamics and so on and making diagnostics of the players' achievements and abilities to make the reflection process more precise.

Activity theory has also applications to the man-machine interface research (Nardi 1996; Kuutti 1996). Within this theory a computer is considered not as a

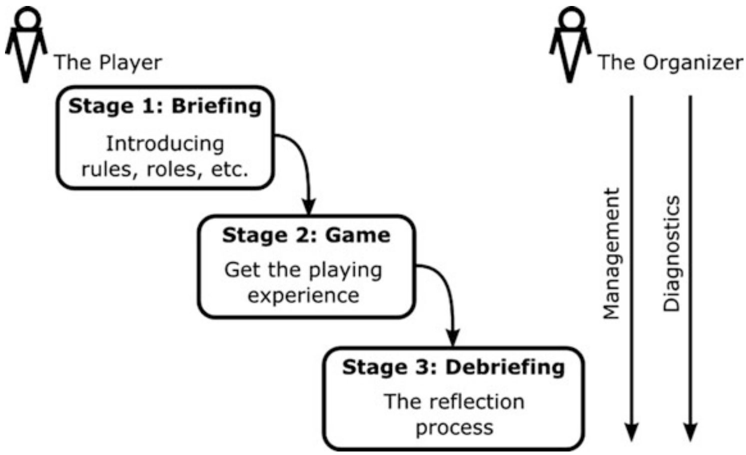

Fig. 2 Educational game structure and process

stand-alone device, but as a part of the framework of some external activity, where computing or working with information is just one of the applied means. The focus of these researches belongs to the activity that embraces a user of an information system (Kaptelinin 2006).

This approach allows us to compare the different formats of educational games. As soon as the games have the same sequence and represent the same activity (including acting positions, methods, values and ethics and so on), we can choose between the particular implementations of the game model of the activity. Here we will try to compare the different types of hybrid computer-mediated formats that can be used to implement the same engineering activity.

To see the role of computer mediation in team-based educational games, we will consider two particular games implemented and run by our team in 2013–2015. These educational games were initially dedicated to solve engineering problems and have live-action, computer-assisted and computer-based formats. We will examine the difference in the game flow for the both cases and will try to compare the observations with the games' runs statistics.

3 Case 1: The Educational Simulation Eco-town

Eco-town is the educational simulation game dedicated to the significance of holistic and systematic view in design activity. Players work in teams and should design a comfortable and ecological town concerning the landscape specifics and minimizing the spent resources. The main game object is a map containing the symbols of buildings, communications and so on. The game can be run in a competitive mode when teams try to find and implement the most effective strategy: the teams' scores are calculated as number of inhabitants divided by the number of consumed materials.

From the positions of the activity theory, this game reconstructs the system design activity. The participants are able to operate the different aspects of the system (like the structure, the processes, the morphology[3]) to design a town as a living system. Therefore, the strategic view is extremely significant to succeed in this game. The postgame reflection is used to highlight the views and methods internalized by the players.

During the game the players perform the actual design: each team receives the unique map and has to plan the town which fits the global goals and the landscape specifics.

The details differ for live-action and computer-based versions of the game (see Fig. 3). In the live-action version, the players are working with draft paper maps and pencils: they are able to draw and erase the town structure. When the town design is ready, the players rebuild the town on the clean map using special coloured stickers. The result is checked by the organizers: are the actions complying to the rules, how many resources consumed, how many scores gained, etc.

The computer-based version is implemented in a way similar to the classic SimCity graphical user interface: the players build the town from elements chosen from the toolbox (roads, communications, schools, hospitals and so on). There are two subsequent stages: the draft mode and the final mode followed by the error checking and score calculation.

The game sequence for the both versions looks very similar, but actual players' behaviour and the educational results are different. We will base our observations on the game runs statistics. In 2013–2015 the game has been run nine times (see Table 1): five in live-action and four in computer-based format. The overall number of participants was 369 schoolchildren (age and sex were different).

There are two types of the average team results represented in this table: the score gained (which corresponds to the effectiveness of the playing strategy) and the number of errors during city construction like negative power balance or disconnected road network (which corresponds to the accuracy of players' decisions). The average participants' results of the live-action version of the game are at least not worse than in the computer-based version (see Table 1). In the computer-based version, the teams made more errors in town planning and gained less score.

The statistical analysis can be extended by the observations of players' behaviour, communication and decision-making during the game as well as the pedagogical analysis of the debriefing stage.

Firstly, in the computer-based version, all teams had a dedicated person who controlled the computer interface of the game with a mouse. Quite the contrary, in the live-action version, the teams had many persons who draw on a map allowing multiple actions on the map simultaneously using several pencils. In this case the

[3] G.P. Shchedrovitsky (2002) has described these system categories in the context of thought-activity theory.

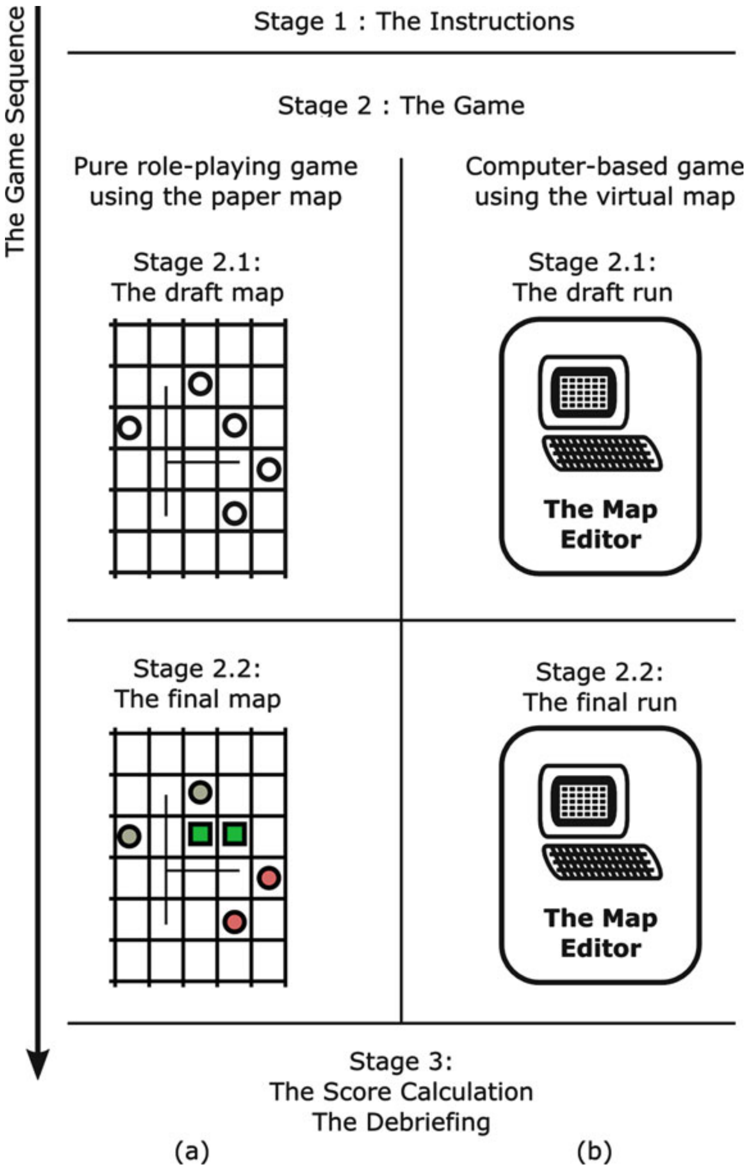

Fig. 3 Comparing the game sequence for the live-action (**a**) and the computer-based (**b**) versions

Table 1 The *Eco-town* game runs overall statistics

The *Eco-town* game version	Overall statistics		
	Participants	Average score gained	Average number of errors
Live-action runs	201	15.2	0.4
Computer-based runs	168	8.7	1.5

computer-based game implicitly reduced the team discussion and made the decision-making process weaker.

Secondly, the computer-based runs took less time in the mean. The possible reason is that the web interface might be more convenient for young participants than paper, pencils and stickers. However, the postgame reflection showed that the players of computer-based version usually had weaker town planning strategies (or even had no consolidated plan at all). In this version many decisions were made on the level of particular choices rather than strategic planning. On the contrary, the live-action run encouraged players to discuss the town plan from the beginning on strategic level working with the draft map.

According to the players' reflection, in the live-action version, more teams were able to reconstruct the systematic view of the town that concluded in the good planning strategy. In opposition, the most players of the computer-based version could not implement the system theory aspects during the game. For instance, those players were not able to separate the material (the available landscapes on the map, the possible buildings) and the structures (the road and the communication networks, the hospital coverage and so on), while the most players of the live-action version were able to draw different layers of the town structures as soon as they already drew it on map using their own graphical definitions. It seems that drawing and scheming practice helped them to conceptualize the considered objects.

As a result, we think that the SimCity-like interface of the computer-based version of *Eco-town* game provokes players to build the town sequentially, while the live-action version with the shared paper map encouraged the strategy planning. From the educational prospective, the live-action version of the game gives better opportunity to engage players into the system design activity and get better learning outcomes.

4 Case 2: The Engineering Game Orbit

The educational game *Orbit* (http://orbitagame.ru) reconstructs the engineering activity of designing a space probe to research Luna, Mars, Venus and other planets. Working in teams the players deal with the physical models of space flight, landing and probe internals like power consumption, heating and so on.

The game flow constitutes the series of the probe life cycles that consist of these steps: (1) analyse the conditions; (2) design the probe, implement the construction applying mathematical models; (3) run the probe putting the specification into the flight simulation; (4) receive the feedback from the telemetry; and (5) draw conclusions.

The game *Orbit* is usually run in the competitive mode: the players' teams should land on a planet and get the better scientific results with minimal resources spent. It should force the participants to make calculations and use engineering knowledge rather than just cut and try.

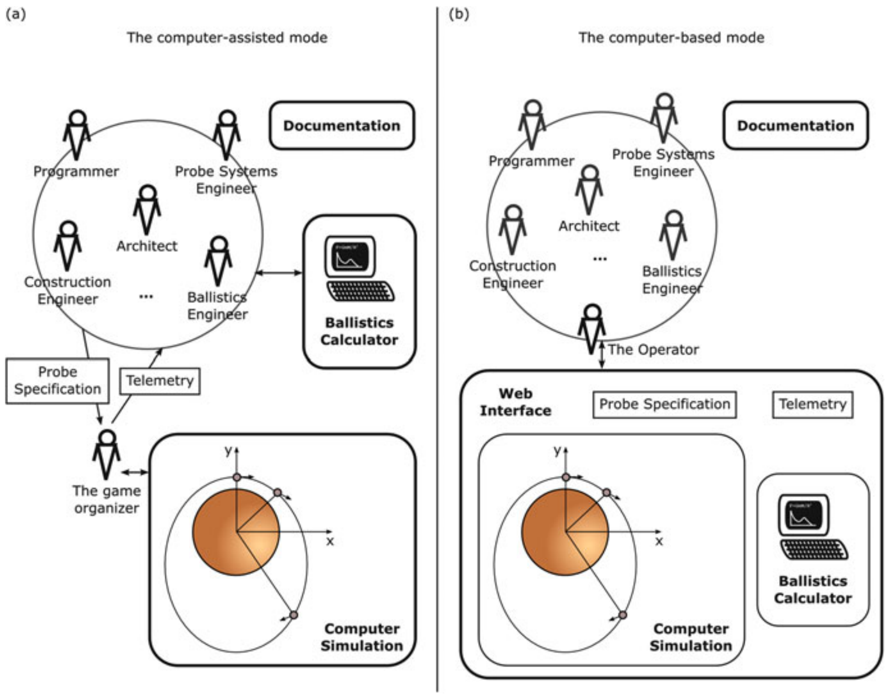

Fig. 4 The orbit game structures for the computer-assisted (**a**) and the computer-based (**b**) runs

From the activity theory viewpoint, this game recreates the multipositional engineering activity: the problem is so complex so it cannot be resolved by a single engineer in short terms; therefore, the team of engineers has to be properly organized (or self-organized in our case). The players have to distribute the positions in the engineering team and find the way to conform the requirements to the subsystems. For instance, the person calculating the ballistic trajectory has to know the probe mass, which depends on the probe internals – the devices chosen by the other player. The participants have special tools and methods to resolve these collisions. The postgame reflection is used to highlight the knowledge and the methods internalized by the players.

The Orbit game depends on the underlying computer simulation. There are two ways of running the game: the computer-assisted and the computer-based mode (see Fig. 4).

The former mode requires only one computer with the calculation model and printer to produce telemetry on paper. The calculations, specifications and telemetry analysis are being done on paper during the group discussions. The organizers are responsible for running the simulation. The personal calculators and computers are allowed, but the computers are of little importance in this format.

In the computer-based mode, the construction part, the mathematical models and the telemetry analysis are incorporated into the single web interface operated directly by players; at the same time, the probe design process still requires teamwork.

The shallow analysis shows the differences between these ways of running the game:

- Multiple tools and artefacts of the computer-assisted mode are replaced by the single-user interface of the computer-based mode.
- The computer-based mode implies using the single media; therefore, the system reaction and the whole probe life cycle are faster for this version.
- The computer-based mode is more convenient for digital data processing by players because in this case, the simulator returns not papers but electronic tables. Usually in every team, the single person (the operator) is dedicated to the computer interface in this mode. This person usually combines this technical activity with one of the design positions. In the computer-assisted mode, there is no such bottleneck.

The deeper analysis shows that we take into account the game runs statistics. Starting from August 2013, the *Orbit* game has been run ten times (seven computer-mediated modes and three computer-based runs). The overall statistics is 1,084 participants (1,009 schoolchildren and 75 university students of different age and sex); 2,926 probes have been constructed and sent into space during the runs. The results differ for computer-assisted and computer-based versions of the game (see Table 2). One can see that the proportional number of launched probes per participant is higher in the computer-based mode. At the same time, the success rate of probe launches in the computer-assisted is higher than 33 % which is a significant number.

This statistics can be extended by the players' behaviour analysis and the pedagogical observations during the postgame reflection. We found that the strong teams which show better results have no difficulties with the both modes of the game – the differences in the game medium and operations are not significant for them. The significant difference can be found for the teams with the lower than average results. In this case the computer-based mode limits the teamwork and tends to be rather "cut and try" than well thought out. The participants more likely create and send probes faster not so concentrated on the team discussions or deep calculations.

Table 2 The *Orbit* game runs overall statistics

The *Orbit* game version	Overall statistics			
	Participants	Probes launched	Probes landed	Probe success percent
Computer-assisted runs	371	417	41	9.8 %
Computer-mediated runs	713	2509	165	6.6 %

We generalized the two considered cases and found the possible reasons of the problems detected in the computer-based versions of the educational games dedicated to teamwork and collective results:

- When a single person tends to occupy the computer interface which plays a crucial role in the computer-based games, the relation between the communication inside the team and the team's actions becomes limited.
- Nowadays the traditional way of using computer interfaces (either PC or smartphone) implies obvious or "cut and try" user activity: it is easier to test and see the results rather than read the instructions (Krug 2000); this behaviour affects the game flow and reduces the players' concentration on the problem-solving.

5 Conclusions

The modern engineering education requires new tools and methods to encourage students' activity and give them engineering experience during the period of study. Teamwork and business communications are the crucial properties of modern engineering work. The educational games or simulations of this kind are highly requested by schools, universities and the industry.

The technology advances and the number of computer-mediated educational games in the engineering sphere is growing rapidly. It is clear that the computer-based (especially online) games have better scalability and many other advantages. However, one should consider the limitations and the pitfalls of computer-based educational tools while building the multiplayer team-based educational games about engineering activity.

This research shows that live-action, computer-assisted and computer-based educational games or simulations have different results. Applying to the teamwork and collective engineering tasks, the computer-based games show weaker results compared to the live-action and mixed-format games with the real communication and shared artefacts. Our estimations show that the problem is connected to the way of working in modern information systems and the role of the single computer interface in the team activity. The particular psychological and sociological mechanisms of this phenomenon are to be intentively researched.

References

Becu, N., Bommel, P., Botta, A., Le Page, C., & Perez, P. (2014). How do participants view the technologies used in companion modelling? In *Companion modelling* (pp. 189–209). Dordrecht: Springer.

Crawley, E. (2001). *The CDIO syllabus: A statement of goals for undergraduate engineering education* (Vol. 1, p. 2001). MIT CDIO report.

Crawley, E., Malmqvist, J., Ostlund, S., & Brodeur, D. (2007). *Rethinking engineering education*. New York/London: Springer, 2.

Crookall, D., Martin, A., Saunders, D., & Coote, A. (1986). Human and computer involvement in simulation. *Simulation & Games, 17*, 345–375.

Crookall, D., Oxford, R., & Saunders, D. (1987). Towards a reconceptualization of simulation: From representation to reality. *Simulation/Games for Learning, 17*(4), 147–171.

Davydov, V. (1999). The content and unsolved problems of activity theory. In *Perspectives on activity theory* (pp. 39–52). Cambridge/New York: Cambridge University Press.

Elkonin, D. B. (2005). The psychology of play. *Journal of Russian and East European Psychology, 43*(1), 11–21.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133–156.

Fedoseev, A., & Vdovenko, D. (2014). Playing science: Role-playing games as a way to enter scientific activity. In *Frontiers in gaming simulation* (pp. 3–12). Springer International Publishing, Switzerland.

Gromyko, Y. (2000). *Thought-activity pedagogics*. Minsk: Technoprint.

International Council on Systems Engineering. (2014). A world in motion – Systems engineering Vision 2025. http://www.incose.org/newsevents/announcements/docs/Systems-EngineeringVision_2025_June2014.pdf. Last Accessed 26 Mar 2015.

Kaptelinin, V. (2006). *Acting with technology: Activity theory and interaction design*. Cambridge, MA: Mit Press.

Klabbers, J. H. (2006). *The magic circle: Principles of gaming & simulation*. Rotterdam: Sense Publishers.

Krug, S. (2000). *Don't make me think!: A common sense approach to web usability*. New Delhi: Pearson Education India.

Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. In *Context and consciousness: Activity theory and human-computer interaction* (pp. 17–44). Cambridge, MA: MIT Press.

Leontiev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs: Prentice Hall.

Luria, A. R. (1976). *Cognitive development: Its cultural and social foundations*. Cambridge, MA: Harvard university press.

Mayo, M. J. (2007). Games for science and engineering education. *Communications of the ACM, 50*(7), 30–35.

Mayo, M. J. (2009). Video games: A route to large-scale STEM education? *Science, 323*(5910), 79–82.

Nardi, B. A. (1996). Activity theory and human-computer interaction. In *Context and consciousness: Activity theory and human-computer interaction* (pp. 7–16). Cambridge, MA: MIT Press.

Oliveira, M. F., Taisch, M., Hauge, J. B., & ckh Riedel, J. (2014). Status and trends of serious game application in engineering and manufacturing education. In *Frontiers in gaming simulation*. Cham: Springer International Publishing.

Palfrey, J., & Gasser, U. (2013). *Born digital: Understanding the first generation of digital natives*. Basic Books, USA.

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the Horizon, 9*(5), 1–6.

Prensky, M. (2005). Computer games and learning: Digital game-based learning. *Handbook of Computer Game Studies, 18*, 97–122.

Rugarcia, A., Felder, R. M., Woods, D. R., & Stice, J. E. (2000). The future of engineering education I. A vision for a new century. *Chemical Engineering Education, 34*(1), 16–25.

Shchedrovitsky, G. P. (1968). *Pedagogy and logic*. Moscow.

Shchedrovitsky, G.P. (2002). Two concepts of system. In J. Willby (Ed.), *Proceedings of the 46th annual conference of the international society for the systems sciences*, Asilomar, CA.

Tapscott, D. (1998). *Growing up digital* (Vol. 302). New York: McGraw-Hill.

Vygotsky, L. S. (1986). *Thought and language*. Cambridge: MIT press.

Wills, S., Leigh, E., & Ip, A. (2011). *The power of role-based e-learning: Designing and moderating online role play*. New York: Routledge.

Warmelink, H. (2013). *Towards playful organizations: How online gamers organize themselves (and what other organizations can learn from them)*. Delft: TU Delft, Delft University of Technology.

Whitton N. (2009) *Learning with digital games: A practical guide to engaging students in higher education*.

Development of Gaming Material and Design Framework for Integrating Entrepreneurship Education into Problem-Based Learning in Mathematics

Kohei Numazaki and Toshiki Matsuda

Abstract Several national and international surveys have showed that a very low percentage of Japanese high school students believe mathematics to be useful in daily life. To rectify this issue, problem-based learning (PBL) was introduced into the Japanese mathematics curriculum. However, it is doubtful whether this change will bring about the intended result. Therefore, we propose to integrate entrepreneurship education into PBL in order to develop an attitude of risk taking by using mathematical ways of viewing and thinking. In this study, we developed a framework for gaming instructional material. Moreover, we conducted a trial lesson to evaluate its effects.

1 Introduction

A very low percentage of Japanese high school students think that mathematics is useful in daily life, and they do not want to work in areas that require learning outcomes of mathematics education (National Institute for Educational Policy Research 2007). PISA's 2012 survey (OECD 2012) revealed that Japanese students' motivation for mathematics learning is the lowest in the world. In order to rectify this issue, the Japanese National Course of Studies (NCoS) was revised in 2009, and problem-based learning (PBL) was introduced into the Japanese curriculum, namely, Mathematics 1 (a compulsory subject) and Mathematics A. However, it is doubtful that PBL in mathematics will play the expected role in the new curriculum. Matsuda and Masuda (2011) pointed out that the problems in the NCoS guidebook and textbooks authorized by the Ministry of Education, Culture, Sports, Science and Technology (2009) were not adequate for cultivating students' abilities to use learning outcomes in problem-solving in everyday life.

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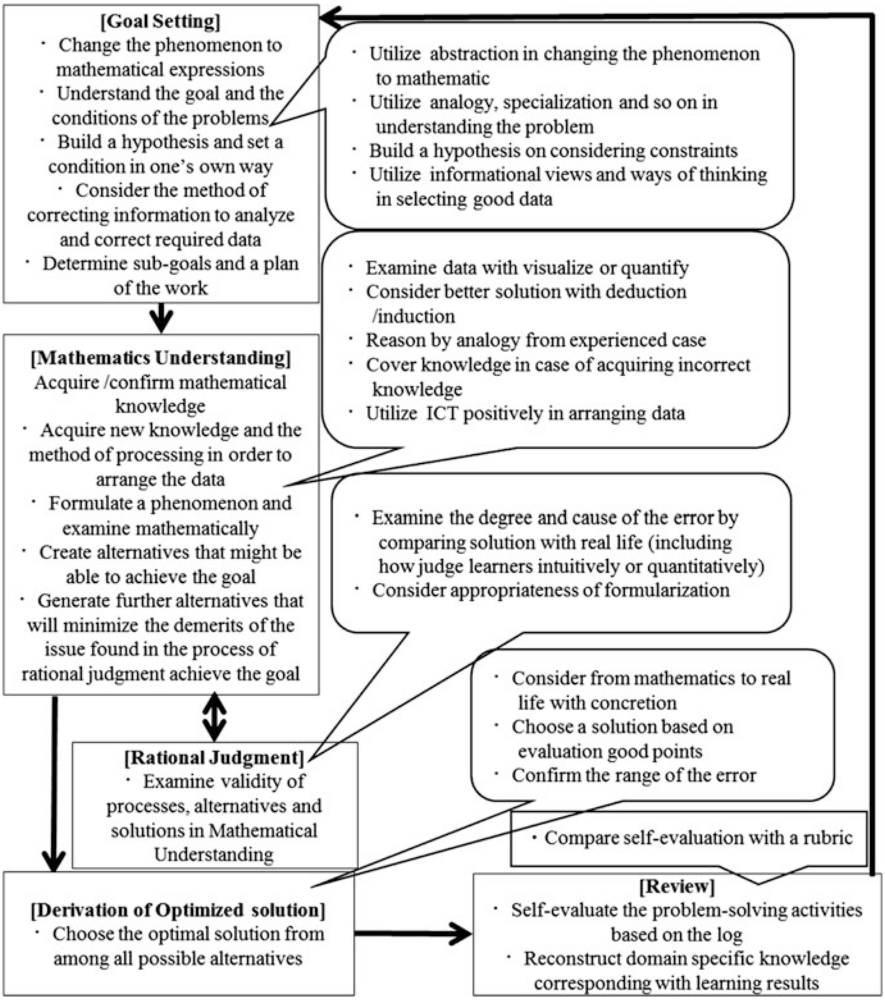

Fig. 1 Ito and Matsuda's (2014) design framework for PBL in mathematics

Therefore, Ito and Matsuda (2013, 2014) have developed instructional materials for PBL in mathematics by introducing gaming methods into some topics related to daily life such as "Which is more profitable: getting employed immediately after graduating from upper secondary school or after graduating from university?" and "Let's make a plan to manage a booth at a school carnival." These methods were developed on the basis of the framework showed in Fig. 1. The framework is composed of three elements: domain-specific knowledge, ways of viewing and thinking, and problem-solving scripts. These elements correspond to Bruer's (1993) statement that domain-specific knowledge, metacognitive skills, and general strategies are all elements of human intelligence and expert performance.

To teach the utilization of mathematics in jobs is important from the view of career education. However, as Shimomura (2008) stated, career education in Japan is not associated with subject areas but is instead focused on providing knowledge about workplace experiences and on lectures conducted by working adults. On the other hand, in the USA, efforts to integrate career education into academic subjects have been made, mainly in social study subjects (Matsumoto 2007).

In addition, many games that have been developed for business and economics education are also used to provide domain-specific knowledge of the subject area, "Social Studies." On the other hand, career education should emphasize cultivation of abilities and attitudes for independent living. Therefore, it is unclear if these games are useful for career education. Moreover, because most Japanese teachers do not have workplace experience outside of schools, they do not have enough confidence to provide career education and tend to rely on lecturers from companies (Hamagin Research Institute 2013). We believe that this is one reason that students do not believe that learning outcomes in academic subject areas are useful in daily life and in their careers. In order to rectify this issue, it is necessary to develop a way to integrate career education into academic subject areas appropriately in Japanese schools.

To this end, we focused on entrepreneurship education. Harada (2013) stated that one of the requirements in the field of business is the "ability to start a new business while being willing to take risks," and that one objective of entrepreneurship education is to cultivate this ability in students. Harada developed the Youth Enterprise system, where students can explain their business plans on Web pages and get feedback from others. This system was developed to offer opportunities to students to develop ideas for new products with companies near their places of residence. However, these activities focused on considering ideas for products and their promotion. It is not necessary to consider financial appropriateness when formulating business plans. The ability to take risks is not sufficient in entrepreneurship education. It is more important to teach students to set high goals while reducing risks through efficient use of data and mathematics.

2 Purpose

Based on the above discussion, we developed a new framework to integrate career education into mathematics education and provide students with the task of creating a business plan. We also developed a gaming material based on the framework in order to conduct a trial lesson and verify the materials' educational effects. There are some gaming materials for entrepreneurship. However, we emphasize mathematics education and introduce entrepreneurship education to provide students with real situations in society.

3 Development of a New Framework

The new framework is shown in Fig. 2. Three elements—problem-solving script (indicated by rectangles), ways of viewing and thinking (indicated by balloons, and mathematical way of viewing and thinking is indicated by ">"), and domain-specific knowledge—were modified from Fig. 1.

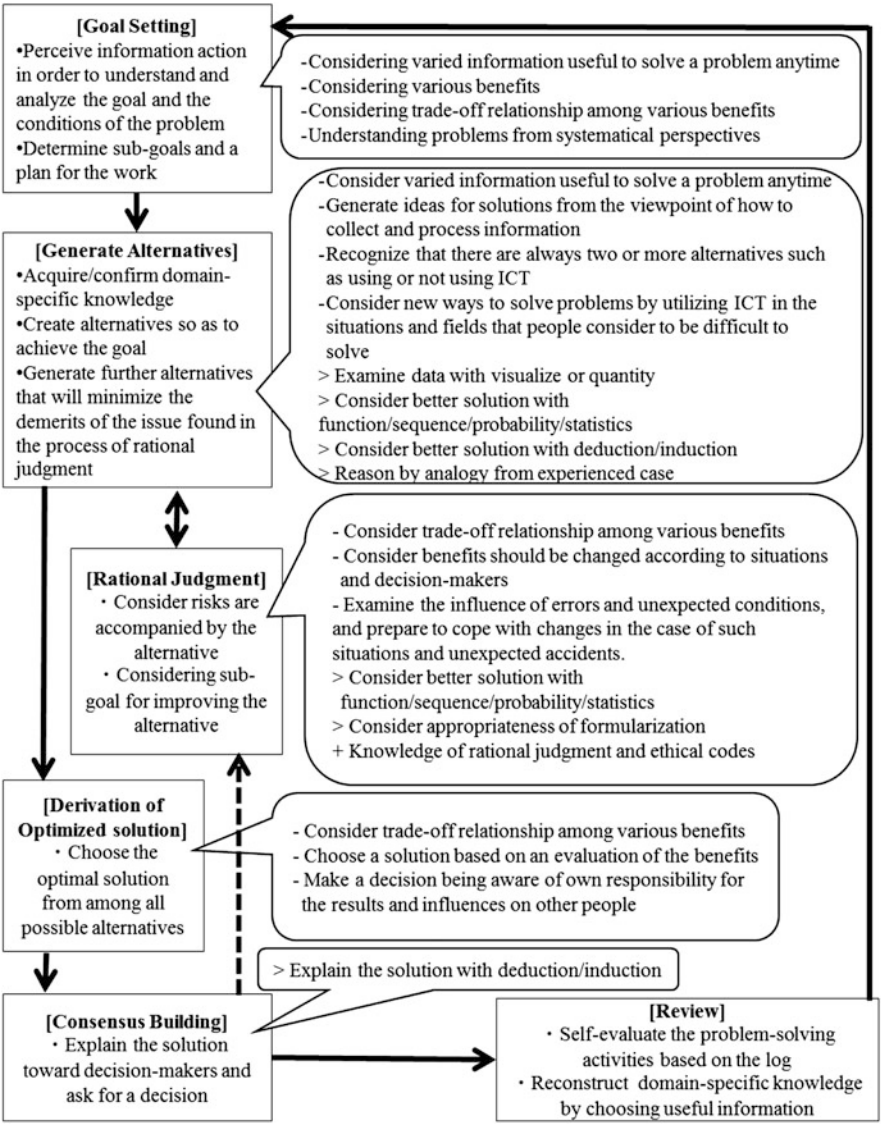

Fig. 2 New framework for integrating mathematics and entrepreneurship education

3.1 Modification of Processes, Tasks, and Ways of Viewing and Thinking

Figure 1 was developed by revising Hirabayashi and Matsuda's (2011) framework for Information Studies. First, we considered "correspondence," which involves a problem-solving script and "Innovation Process." Innovation Process, which is taught in entrepreneurship education, is composed of the following: (1) investigation, analysis, and opportunity recognition; (2) creation of ideas; (3) resource acquisition and networking; (4) realization of ideas; (5) rational judgment of ideas; and (6) creation of a new value. Therefore, we connected the Innovation Process to the problem-solving script while revising it as shown in Fig. 3. We changed the name "Mathematics Understanding Process" to "Generate Alternatives Process," as the purpose of our framework is not limited to mathematics. In addition, the purpose of making business plans is to persuade decision makers to invest money into the business, so we added "Consensus-Building Process," which Katto et al. (2013) proposed in a framework for science education and technology communication. In this process, players can explore number profitability and the necessity of using mathematics in business.

Figure 2 got rid of some tasks from Fig. 1 because of the following reasons. First, PBL in mathematics requires making formulas from problems in daily life in the second and third tasks of the Goal-Setting Process. However, our framework prompts students to summarize the results of problems into a business plan. Therefore, our framework does not need to provide students with the freedom to

Fig. 3 Relationship with processes

Problem-solving process in Fig. 1	Innovation process
Goal Setting	Investigation, Analysis
Generate Alternatives	Investigation, Analysis, Opportunity recognition Resource acquisition and Networking Create ideas Realization of Ideas
Rational Judgment	Investigation, Analysis Rational Judgment of Ideas
Derivation of Optimized Solution	Create a new value
Consensus building	Resource acquisition
Review	

choose appropriate formulas; rather, it needs to focus on understanding the purpose of making business plans and tasks. This is why we deleted "mathematical ways of viewing and thinking" (first to third items) in the Goal-Setting Process. On the other hand, we indicated the "informatics and systematic way of viewing and thinking" (the fourth item) explicitly.

In the Generate Alternatives Process of Fig. 1, "Searching for Information," "Minimizing Investment," and "Maintaining Flexibility" were stated in Shane (2004) as required tasks for entrepreneurs when considering strategies for declining risks. In addition, the meanings of alternatives are different between Figs. 1 and 2. In the former, alternatives mean mathematical methods, but in the latter, they mean business plans, such as choosing combinations of product ideas, main customer, regular price, and selling quantity, all of which influence the degree of risks and benefits. In the ways of viewing and thinking, we added informatics and a systematic way of viewing and thinking for the first task in this process that is pointed out by Matsuda (2015). We considered the "Minimizing Investment" and "Maintaining Flexibility" correspondence with ways of viewing and thinking of the function, probability, and statistics. Hence, we remain mathematical ways of viewing and thinking as far as they do not overlap with informatics and systematic ways of viewing and thinking.

In the Rational Judgment Process, the first task, "Examine validity of processes, alternatives, and solutions in Mathematical Understanding," was changed to focus on the evaluation of risks. In addition, informatics and systematic ways of viewing and thinking related to the consideration of risks were added. However, some mathematical ways of viewing and thinking were removed in lieu of emphasizing informatics and systematic way of viewing and thinking. Moreover, mathematical ways of viewing and thinking related to the evaluation of risk were added.

The Derivation of Optimized Solution Process remained the same as in Fig. 1, but the Consensus-Building Process was added in, in accordance with Matsuda (2015). However, as Matsuda (2015) did not show any way of viewing and thinking for this process, in Fig. 2, we added a mathematical way of viewing and thinking: "Explain the solution with deduction/induction."

3.2 Domain-Specific Knowledge

Though the framework of Fig. 1 does not require any domain-specific knowledge, our framework requires the following two kinds of domain-specific knowledge. The first is internal knowledge that should be remembered, and the second is external knowledge that is not necessary to be remembered but should be referred to. Internal knowledge corresponds to "big ideas" in the theory of "Understanding by Design" (Wiggins and McTighe 2006). Big ideas must be conceptual tools useful in broader contexts. Because our framework is supposed to treat risks, viewpoints that will help to forecast risk factors are adequate as big ideas. For such ideas, we used the rational judgment framework (Fig. 6), which was originally proposed by Tamada and Matsuda (2004) for cyber ethics education and used in many contexts such as Exploration Activities in science (Taguchi and Matsuda 2015) and Engineering Ethics education (Endo and Matsuda 2012). On the other hand, technical knowledge required to make real business plans, such as Marketing and Pricing, is external knowledge.

4 Development of a New Gaming Instructional Material

We developed a gaming instructional material based on the new framework. The objective of the game was to prepare a business plan for opening a bakery. The reason we chose this topic is that bakeries were popular in Harada's Youth Enterprise, and we expected upper secondary students to be relatively familiar with them.

At the beginning of the game, we introduced the framework and asked some questions to clarify the necessity of the framework while presenting the following case: "Let's make a plan to raise sales of a travelling agency." The first example showed a case where the Generate Alternatives Process started without the Goal-Setting Process. The second example showed a case where neither an alternative-generated nor critical discussion performed in the Rational Judgment Process. After showing each example, we asked the players, "This process of discussion has problems. Can you identify them?"

Next, we explained the necessity of ways of viewing and thinking while showing a case, "Let's make a new ice cream product." Players were asked to provide the most appropriate mathematical way of viewing and thinking about the question, "Consider a new product from finding a thing in common among popular ice cream products." Based on the responses, our gaming material returned a feedback message to the player to prompt an appropriate understanding of problem-solving frameworks and ways of viewing and thinking.

4.1 Goal-Setting Process

In this process, to understand and analyze the goals and conditions of the problem is the first task. In the second task, players need to determine policies of business plans as sub-goals and develop a work plan. Therefore, as the first step, the objective "to sell a new product, Panini, at a bakery that has the problem of stagnant sales" was given. The goal was to develop a business plan to obtain a loan for selling a new product, and the condition was that the loan needed to be repaid in 10 months.

When players determine sub-goals, they need to consider ideas such as "decliner cost," "risk assessment," and "maximum benefit" as well as consider trade-off relationships among them based on ways of viewing and thinking. When players

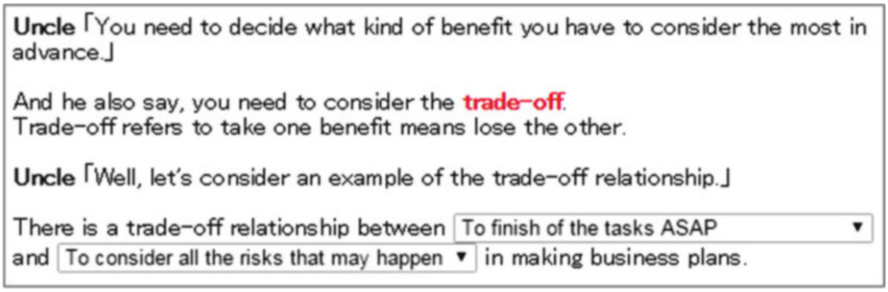

Fig. 4 Utilizing informatics and determining a systematic way of viewing and thinking

consider work plans, they need to consider what information is needed for generating business plans, as well as effective collection methods (Fig. 4).

4.2 Generate Alternatives Process

In this process, as the first task, players collected information according to the plan generated in the Goal-Setting Process. When developing business plans, the players were asked to consider the marketing aspect. For example, *Globis* University (2009) introduced the method of considering the 3Cs (company, competitor, and consumer, which should be clarified for understanding business environments), the STP (segmentation, targeting, and positioning, which should be built as business concepts), the 4Ps (product, price, place, and promotion, which should be viewed as business details), etc. In accordance with this method, players were asked to collect information about "product ideas for Panini, suppliers, machinery, advertisement strategies, income, and expenditure plan" with the help of the Internet, books, consultation with others, or referencing similar cases from the past. As a result, players were able to obtain data such as the population of the region and the ratio of takeaway and then analyze the data by means of statistical ways of viewing and thinking, which are a part of mathematical ways of viewing and thinking.

For the second task, players needed to create business plans based on the collected data by means of analogy, induction, and deduction. Players were asked to think about product ideas, main customers, suppliers, machinery, advertisement methods, regular price, selling quantity, and selling goal for their business plan. Here, regular price, selling quantity, and selling goal are considered by using a break-even point provided as an Excel sheet, based on functional ways of viewing and thinking (Fig. 5).

Fig. 5 A part of the Excel sheet

4.3 Rational Judgment Process

In this process, players were required to revise the business plan according to whether there were any problems related to the three viewpoints in Fig. 6, which shows a revised version of the rational judgment framework (Tamada and Matsuda 2004). First, players asked themselves, “Have you got permission for selling?” This made players consider whether there were any problems related to licenses, etc. Second, players asked themselves, “Is the supplier reliable? (Will the quality of the materials satisfy customer needs?”) Third, players needed to ask, “Have you chosen any defective machines?” Players were also required to consider the issue of price setting again because costumer value is not considered on the basis of any data in the Generate Alternatives Process.

As their third task, if players find any issues in this process, they need to consider alternatives in the Generate Alternatives Process, in order to revise their business plans.

4.4 Derivation of Optimized Solution Process

Players chose an alternative as the optimized plan after going through the Generate Alternatives Process and the Rational Judgment Process. To decide the best

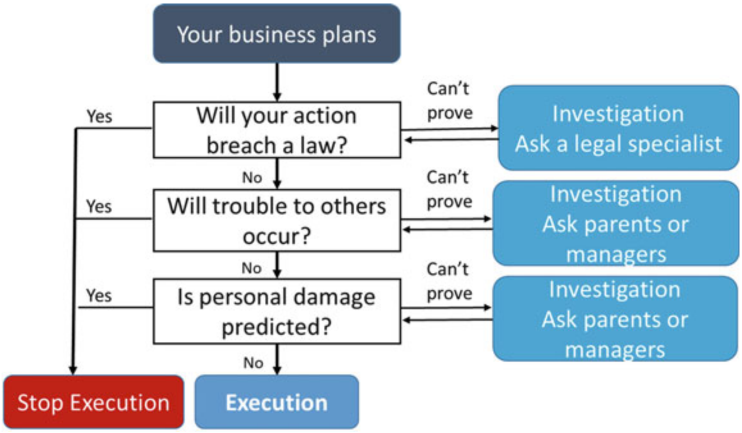

Fig. 6 Rational judgment framework for cyber ethics (Tamada and Matsuda 2004)

business plan, they were required to consider risks and responsibilities of utilizing informatics and determining systematic ways of viewing and thinking.

4.5 The Consensus-Building Process

In this process, players were required to explain the business plan to the decision maker from whom they intended to avail a loan. When explaining the plan, they needed to use induction/deduction based on collecting data.

There can be diverse explanations, depending on how much data is collected and analyzed by them by means of induction. Data were collected on population, ratio of takeaway, health needs, etc. If players gathered population data, they would probably find that men in their 30s are the biggest volume zone. If they only researched the ratio of takeaway, they would probably find that women in their 20s are the biggest volume zone. On the other hand, if they gathered both data, they would find that men in 50s are the biggest volume zone.

Success or failure is determined by the decision maker, depending on the response to the question "Can the loan for the business plan be repaid in 10 months?" If the response was yes, players received feedback from the system and moved on to the Review Process. If the response was no, they returned to the Rational Judgment Process to revise their business plans.

4.6 Review Process

All of the players' choices were saved in a log. This provided players with occasions to reflect on their activities. The system could also return feedback information based on the log. After receiving the feedback, the player is prompted to acquire the necessary knowledge/confirm that they have acquired the necessary knowledge.

In this game, success or failure was judged according to whether players' behaviors were in line with the framework and whether risks appropriately reduced in the Rational Judgment Process.

5 Practice and Evaluation of Materials

After developing this gaming material, we conducted a trial lesson for 26 students at Edogawa University. We then asked students to answer a questionnaire, the results of which are shown in Table 1. Students were asked to rate certain items on the questionnaire on a 5-point scale before and after using the gaming material. Students were also asked to answer descriptive questionnaires.

5.1 Results

We conducted a Wilcoxon signed-rank test on our data, which was gathered from 17 students who were able to finish playing with our gaming material. The results are shown below.

Table 1 Mean and SD pre- and post-questionnaires

Items	Pre	Post	*P*-value
Q1. I know what a business plan is**	1.9(1.3)	3.6(0.8)	0.16 %
Q2. I am good at solving problems	2.6(0.8)	2.5(0.9)	74 %
Q3. (Pre) I use problem-solving processes in daily life → (Post) I know the importance of problem-solving processes in daily life (**)	2.4(0.8)	3.9(1.0)	0.22 %
Q4. It is important in problem-solving to concentrate on using mathematical ways of viewing and thinking	3.4(1.1)	4.0(0.9)	15 %
Q5. I am good at using mathematical ways of viewing and thinking	2.4(1.1)	3.2(1.1)	6.1 %
Q6. It is important to acquire specific knowledge on a variety of topics	4.0(0.8)	4.0(0.9)	100 %
Q7. It is important to acquire mathematical ways of viewing and thinking in a variety of topics	3.8(0.8)	3.8(0.9)	78 %
Q8. Mathematics could be useful for future jobs*	3.4(1.1)	3.9(1.1)	3.7 %

(** 1 %,* 5 % are the significance levels)

It was found that the gaming material was useful for making students aware of the usefulness of mathematics in society. The responses for the items "I know what a business plan is" and "Mathematics could be useful for future jobs" were statistically significant. However, students did not seem to think that using mathematical ways of viewing and thinking was important.

5.2 Discussion

Nine out of 26 students could not complete the gaming material. The average time for completing the game was 50 min, and the maximum time was 73 min. Playtime tended to depend on repetition between primarily the Generate Alternatives and Rational Judgment processes and on reading and understanding of problems in the Goal-Setting Process. Some students provided the following comments in the post-questionnaire: "The game should be modified so that one need not go back repeatedly," "The game should be shorter," "The sentences in the game should be shorter," and "The words used in the game were difficult to understand."

In addition, few students acknowledged the importance of utilizing mathematical ways of viewing and thinking. The reason for this was probably insufficient instructions. The gaming material did not indicate mathematical ways of viewing and thinking explicitly in its feedback. Therefore, it was difficult for students to consciously use mathematical ways of viewing and thinking.

6 Conclusion and Future Perspectives

We developed a framework for using mathematics, information, and entrepreneurship education. The trial lesson showed that students understand the usefulness of mathematics in the society. Next, we intend to refine the instructions in the gaming material and further develop our framework before conducting more trial lessons.

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References

Bruer, J. T. (1993). *Schools for thought: A science of learning in the classroom*. Cambridge, MA: The MIT Press.

Center for Entrepreneurship Development, Youth Enterprise. http://www.youthenterprise.jp/

Endo, S., & Matsuda, T. (2012, December). Development of a new high school instructional material for engineers' moral education: Introducing science and technology communication. In H. Middleton (Ed.), *Exploration of best practice in technology, design & engineering education* (Vol. 1, pp. 79–87). Australia: Griffith University.

GLOBIS University. (2009). *MBA marketing*. Tokyo: DIAMOND, Inc.

Hamagin Research Institute. (2013). *Reconnaissance report of career education for more enrich and more popular*. Retrieved from http://www.meti.go.jp/policy/economy/jinzai/ccaree-education/pdf/h24survey_honbuh.pdf

Harada K. (2013). Chapter 6, Entrepreneurship education, Nishioka Syoko & Oketani Mamoru, Student counselling and career education in lifelong learning time (pp. 183–190). Tokyo: KYOIKU-SHUPPAN Co., Ltd.

Hirabayashi, S., & Matsuda, T. (2011). *Constructing design principles for developing gaming instructional materials for making cyber ethics education authentic*. Proceedings of E-Learn 2011 (pp. 1280–1288). AACE: Chesapeake.

Ito, Y., & Matsuda, T. (2013). *Design framework of problem-based instruction in mathematics and development of a lesson plan and e-learning material for the lesson*. Proceedings of the 11th annual Hawaii international conference on education (pp. 2106–2117). Honolulu: Hawaii International Conference on Education.

Ito, Y., & Matsuda, T. (2014). *Improving the design framework of problem-based instruction in mathematics based on the student model*. Proceedings of the 12th annual Hawaii international conference on education (pp. 2517–2529). Honolulu: Hawaii International Conference on Education.

Katto, Y., Matsuda, T., & Endo, S. (2013). Considering science and technology communication literacy for all and developing an e-learning material to cultivate it. *Research Report of the Japan Society for Educational Technology Conferences, JSET, 13–2*, 1–8.

Matsuda, T. (2015). *Design framework of gaming materials to cultivate problem-solving abilities: Differences and commonalities within STEM Education*. 13th annual Hawaii international conference on education (pp. 2147–2159). Honolulu: Hawaii International Conference on Education.

Matsuda, T., & Masuda, K. (2011). *Issues necessary to be improved before starting new high school math curriculum: Based on an analysis of textbooks and lesson plans written by pre-service teachers*. Research report of the Japan Society for Educational Technology Conferences (JSET 12-3) (pp. 59–60). Matsue: Shimane University.

Matsumoto, K. (2007). The theoretical development and practices of "contextual teaching & learning" in US career education: Focusing on instructional practices in academic subjects at the secondary education level. *The Japanese Society for Curriculum Studies*, *16*, 15–28.

Ministry of Education, Culture, Sports, Science and Technology. (2009). *National course of studies for upper secondary schools*. Retrieved from http://www.mext.go.jp/component/a_menu/education/micro_detail/__icsFiles/afieldfile/2012/06/06/1282000_5.pdf

National Institute of Educational Policy Research. (2007). *Investigations of academic ability and an attitude survey on the feelings of children with regard to their studies at upper secondary school level in 2005*. Retrieved from http://www.nier.go.jp/kaihatsu/katei_h17_h/h17_h/05001000040007004.pdf

OECD. (2012). *OECD Programme for International Student Assessment (PISA)*. Retrieved September 27, 2013. http://www.pisa.oecd.org/pages/0,3417,en_32252351_32235731_1_1_1_1_1,00.html

Shane, S. A. (2004). *Finding fertile ground – Identifying extraordinary opportunities for new ventures*. Upper Saddle River: Pearson Prentice Hall.

Shimomura, H. (2008). *Career education efforts in industry and regional affiliate. The trend and movement on career education*. Tokyo: Employment Research Corporation.

Taguchi, H. & Matsuda, T. (2015). *Improvement in the design framework of instructional gaming materials for scientific exploration activities through the development of a new game*. The 13th Hawaii international conference on education (pp. 2480–2489). Honolulu: Hawaii International Conference on Education.

Tamada, K., & Matsuda, T. (2004). Development of the instruction method of information morals by "the combination of three types of knowledge". *Japan Journal of Educational Technology, 28*(2), 79–88.

Wiggins, G., & McTighe, J. (2006). *Understanding by design* (Expanded 2nd ed.). Upper Saddle River: Pearson Education.

Understanding the History of International Politics: A Retrospective and Repeated Type of Gaming and Simulation in the Classroom

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Abstract The purpose of this paper is to develop multilayered views of rules of gaming and simulations of international politics, especially with respect to the changeability of rules. In this case study, students play a role-playing game of the 2010 Senkaku boat collision incident. Many kinds of games and simulations of international politics are recognized today, but most of them use fixed rules. In real society, including international relations, rules and institutions are not continuous for forever; they are changeable and evolving because actors influence systems in the same way as they change systems. The "Senkaku game" is a trial of a history retrospection and a repeated type of gaming and simulation with this ability. This game is a simulation of a series of occurrences involving the arrest and indictment of the captain of a Chinese fishing boat by Japan in the Senkaku/Diaoyu Islands. The actors are Japan, China, and the United States. The goal of playing the game is to reflect on and replay the incident, which factors are important and which factors and actors prefer which options and when. We would like to show this game not as a reiterative game for the future but as a historical reality. By understanding the historical reality through the theories of international relations, the results of the game can mainly be explained by neorealism. In reality, however, Japan and China reached a compromise based on a neoliberal institutionalist understanding. As a result of the first game, students discussed how they would change the rules and then played again with the changed rules to approach the historical reality. This game simulation led students to understand the history of international diplomacy and politics more easily.

Keywords International politics • Senkaku/Diaoyu Islands • Diplomatic history • Retrospect • Prisoner's dilemma

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Understanding International Politics through the Gaming Simulation

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1 Introduction to the Simulation

The purpose of this paper is to develop a multilayered view of the rules of gaming for and simulations of international politics, especially with respect to the changeability of rules through the exercise and analysis of a game and simulation about the 2010 Senkaku boat collision incident.

Games and simulating international politics can be traced back to board games that copied and abstracted battles, such as the games go, shogi, and chess, although these games are mainly for entertainment. The use of games and simulations, such as for academic research efforts and exercises, has mainly been led at universities and institutes in the United States since World War II. Models of gaming and simulations reached their peak in the 1960s but declined in the 1970s because of issues with the validity. On the other hand, in the United States and other countries, gaming and simulations are still used as education and policy-making tools at universities and institutions.

Many kinds of games and simulations of international politics are recognized today (cf. Loggins, 2009, pp. 401–407), and most use fixed rules. However, can we think of another type of gaming and simulations? Actors, such as states and persons, and systems mutually influence each other and work in dynamic ways, not only in international politics but also in society. Thus, rules and institutions are not continuous forever; they are changeable and evolving. Actors influence systems; systems are changed, and they change actors at the same time.

Based on real society and international relations, can gaming and simulations use changeable rules? The "Senkaku game" discussed below is a trial of a history retrospection and a repeated type of gaming and simulation with this ability. We call this type of gaming and simulation repeated and retrospective (R&R) type of simulation game.

The Senkaku game is a simulation of a series of occurrences involving the arrest and indictment of the captain of a Chinese fishing boat by Japan in the Senkaku/Diaoyu Islands (hereinafter the Senkaku Islands), which occurred in 2010. The actors are Japan, China, and the United States, which also serves as chairperson. The goal is to reproduce an incident that actually occurred in a simulation game. Secret goals and restrictions are given to each actor. The simulation game is conducted to follow the rules.

A feature of this simulation game is that the rules change to reproduce the incident, but the actors themselves do not change. This is a rule-oriented type of simulation game. As players also learn the situations, of course, a change of rules alone does not necessarily result in a change to an actor's actions. However, the main purpose of this simulation game is to change the external conditions of the framework.

This kind of *rule-oriented view* is another approach to gaming and simulation[1] based on the tendency of games and simulations to copy reality by bringing actors

[1] Tadashi Okano (2006) once proposed a "rule-generation type of gaming and simulation." This paper is partly based on his idea. We express our appreciation of him.

close to reality. For example, Hermann and Hermann (1967, pp. 400– 416; Hermann 1989, pp. 365–380) carried out a simulation game about the outbreak of World War I. They used psychological tests and chose players whose personalities resembled those of major political leaders to try to control the simulation game through the actors' behavior. Of course, this is a usual type of approach to simulation games of international politics. However, we can seek another type of simulation gaming.

Although the Senkaku game was not created from such a viewpoint at first, the players received opportunities to think about the relations among rules, systems, and actors from rule-oriented view.

We would like to discuss the Senkaku game and the results of one exercise of the game, as well as an analysis of IR theories. We argue that simulation games with changeable and evolving rules have multiple levels.

2 The Repeated and Retrospective (R&R) Type of Simulation

Game on the Diplomacy Surrounding the Senkaku Boat Collision Incident in September 2010

2.1 Historical Background of the 2010 Collision Incident

The islands that the Japanese government calls the Senkaku Islands, which their Chinese and Taiwanese counterparts call Diaoyu-Tai (Diaoyu-Yu) and Diaoyu-Shan (Diaoyu Dao), are located in the East China Sea. China, Japan, and Taiwan have each claimed territorial sovereignty over the islands, especially since 1971.[2] The territory consists of eight small islands that are now uninhabited, although Japanese people lived on them in the past. Taiwan and China have insisted on their legitimacy in claiming territorial sovereignty over the islands because of an annexation based on the peace treaty that ended the Sino-Japanese War in 1895. Japan has insisted that the islands have always been an inherent part of Okinawa Prefecture. Many fishing boats operate near the islands, and some Chinese and Taiwanese fishing boats have operated in the vicinity under de facto Japanese control.

On September 7, 2010, a fishing trawler from mainland China was fishing near the islands when it collided with a boat from the Japan Coast Guard (JCG). The JCG arrested the captain of the ship, but both sides claimed that the other intentionally

[2] For more information on this conflict, see the statement by the Chinese government on the islands: http://www.diaoyudao.org.cn/en/201501/22/content_34626699.htm; and that of the Japanese government: http://www.mofa.go.jp/region/asia-paci/senkaku/.

caused the collision. Two days later, the JCG sent the captain of the ship to a district prosecutor, in order to be charged with obstruction of a public officer.

China urged Japan to immediately release the captain and his crew, but on September 10, the local public prosecutor's office extended the captain's detention. Because of this situation, China canceled some diplomatic meetings with Japan, even though the trawler and the other crew members besides the captain had been released. Opposing his detention, China detained four Japanese businesspersons of a Japanese corporation in China for allegedly filming military targets. On September 24, Japan released the captain, and on October 9, all of the Japanese businesspersons were released by China. In November, a video of the collision was leaked to YouTube.

During this period, the heads of the two states took part in international conferences, including the UN General Assembly in New York City, the ASEM in Brussels, and the G20 Meeting in Seoul, but there were no bilateral meetings with fruitful results on this issue. For the success of the APEC meeting in Yokohama (November 2010), the Ministry of Foreign Affairs of Japan felt that it was imperative not to let the Chinese president cancel the Yokohama meeting because of the collision. Additionally, the Japanese economy depended on Chinese markets and materials, especially rare metals from China. On the other hand, both for China and Japan, the disputes over the island become more and more insoluble because the patriotic passion surrounding the issue grew in each nation year by year.

2.2 *Game Rules (Rules for the First Time Playing)*

2.2.1 Actors

The actors shall be the three states, Japan, China, and the United States (who must also serve as chairperson). They shall completely exclude internal actors (provincial or bureaucracy levels of government, media, NGOs, companies, specialists or civilians, etc.) according to their respective, rationally selected models of international politics. However, the interests of these internal groups are embedded to some degree in secret goals and conditions (see the Tables 1 and 2).

2.2.2 Educational Goal of This Game

The purpose of this game is to let students play the roles of the state actors that negotiated with each other regarding this issue; as if they were working *inside* the state actor, they will know the vital and changing national interests and perceptions. Additionally, we call this type of gaming "repeated and retrospective" (R&R). In R&R-type games, the students first play the game. Upon review, they will consider the gap between the gameplay and history. Then, they will alter the rules of the game and play again. Through this repetition process, the students are expected to

Table 1 Proceedings of the game ※ each round, the order of the presentation of state actors is as follows: Japan → China → United States

R.1*	Sept. 11–13	J-R:Do not release the captain/C-R:do not enact sanctions
Event	Sept. 14	
R.2	Sept. 15–18	J-G:Do not release the captain (+5), indict captain (+7)
		C-G: Allow the captain's release (+5) US-R: Present a declaration pushing for resolution
R.3	Sept. 19–20	J-G: Announce the extension of the detention (+3), indict the captain (+5) C-G: Allow the captain's release (+2)
		C-R:If goals "a" and "b" have not been achieved, enact sanctions
Negotiation phase	Sept. 21–23. United Nations (NY): three-party talks are not allowed	J-G: Make the United States state the applicable condition of the US–Japan Security Treaty (+5)
		J-R: Request that the United States state the applicable condition of the US–Japan Security Treaty
		C-R:If goals "a" and "b" are not achieved, enact sanctions
		US-R: If China implements sanctions press for a resolution. If Japan refuses, threaten to not declare the applicable condition of the US–Japan Security Treaty
Negotiation phase	Sept. 24–30	J-G: For each employee released (+1)
	Japan and China: Completely secret negotiations	If economic sanctions are lifted in the same phase as they are implemented (+2) JR:If the detained without indictment, whether or not he shall be indicted must be determined. If not indicted, release him
	Japan dispatches one secret messenger to China	C-G:If Japan promises to goals "d" and "e" (+2)
		C-R: If Japan agrees to goals "d" and "e", release some of the employees. Behave accordingly at the next negotiations if total points are +20
Negotiation phase	Oct. 1–4. The ASEM (Brussels)	C-R: If total points do not reach +20, negotiations with Japan do not apply. US-R: The United States cannot negotiate
	Negotiations between Japan and China	
Event	Oct. 8	
R.4	Oct. 9–26	J-G: For each employee released (+1)
		If economic sanctions are lifted (+1)
		C-G: Convey an attitude of diplomacy to Japan regarding the next negotiation

(continued)

Table 1 (continued)

		phase in Hanoi through a secret letter. /US-R:If economic sanctions have not yet been lifted, demand that China lift them
Negotiation phase	Oct. 27. Hawaii	J-R: Make the United States reconfirm matters relating to goal "e", and have them state this to the world (+3)
	Negotiations between Japan and the United States	C-R: China cannot participate in these negotiations
Negotiation phase	Oct. 29. Hanoi Negotiations between Japan and China	US-R: The United States cannot participate in these negotiations
R.5	Oct. 30–Nov. 3	J-G: If video is not even partially leaked to the Diet (−2)
Event	Nov. 4	
R.6	Nov. 5–10	J-R: Demand compensation for patrol boat's repairs from China
Negotiation phase	Nov. 11–12. The G20 in Seoul, formal discussion between the United States and China during a summit meeting	Although Japan is a member of the G20, they may not participate in this formal discussion
Negotiation phase	Nov. 13–14. The APEC summit in Yokohama: three-party talks are not allowed	J-G: Keep goals "c" and "d" in mind. C-R: If China has 10p or more at this point, Hu Jintao may attend the APEC summit. If more than 15p, a meeting between Japan and China may apply. If China has less than −10p, Hu Jintao may not attend
R.7	Nov. 15–22	C-R: Lift economic sanctions against Japan if China has over 10p at this point
End		

approach the historical facts they perceive, and the rules of the game itself will become more perfect.

Based on the reality they perceive, this game belongs to the category of "incomplete" games, in which players do not know the others' goals, interests, or restrictions. The goals are kept secret. However, after the second game, the players will change the actors' goals and restrictions based on each stage of the history, making this a "rule-generating" game.

2.2.3 Running the Simulation in the Past

This game was first run in December 2010. After the first trial, the players innovated new rules; since then, this game has been played annually in the Seminar (International Politics) class and the Crisis Management Simulation class. The next chapter is based on the March 2015 playing of the game in the seminar.

Table 2 Acquired point for both states

R.1		Japan:0
Sept. 11–13		China:0
R.2		J-G:Do not release the captain (+5)
		C-G: None
Sept. 15 + 18	(Point)	Japan:+5
		China:0
R.3		J-G: Announce the extension of the detention (+3), indict the captain (+5 + 30), diplomatic sanction by China (−5) and cultural sanction by China (−5)
Sept. 19–20		C-G: Indictment of captain by Japan (−20)
	(Point)	Japan:+5 − 10 + 3 + 5 + 30 = +33
		China:0 − 20 = −20
Negotiation phase	United Nations (NY)	J-G: Restriction of four Japanese employees (−2 × 4) and economic sanction by China (−5)
Sept. 21–23		C-G: None
	(Point)	Japan: +33 − 2 × 4 − 5 = +20
		China: −20
Negotiation phase	Negotiations between Japan and China	J-G: One employee released (+1)
Sept. 24–30		C-G: The declaration of Japan as not to open their visual sources about Senkaku incident (+5)
	(Point)	Japan: +20 + 1 = +21
		China: −20 + 5 = −15
Negotiation phase	The ASEM. Negotiations between Japan and China	
Oct. 1–4		J-G: None
		C-G: None
R.4		J-G: None
Oct. 9–26		C-G: None
Negotiation phase	Hawaii. Negotiations between Japan and the United States	J-G: Make the United States reconfirm matters relating to goal “e,” and have them state this to the world (+3), and the United States reconfirms that Senkaku Island is their protectoral area under the Security Treaty (+5)
Oct. 27		C-G: Make the United States reconfirm matters relating to goal “e,” and have them state this to the world (−10)
	(Point)	Japan: +21 + 5 + 3 = +29
		China: −15 − 10 = −25
Negotiation phase	Hanoi	J-G: None
Oct.29	Negotiations between Japan and China	C-G: None
R.5		J-G: None
Oct. 30–Nov. 3		C-G: None

(continued)

Table 2 (continued)

R.6		J-G: None
Nov. 5–10		C-G: None
Negotiation phase	The G20. Discussion between United States–China	J-G: None
Nov. 11–12		C-G: None
Negotiation phase	The APEC summit	J-G:The United States reconfirm that Senkaku Island is their protectoral area under the Security Treaty (+2)
Nov. 13–14		C-R: The United States reconfirm that Senkaku Island is their protectoral area under the Security Treaty (−10)
	(Point)	Japan: +29 + 2 = +31
		China: −25 − 10 = −35
R.7		Japan: None
Nov. 15–22		China: Indictment of other crew (−10)
End (total point)		Japan: +31
		China: −25 − 10 = −35

3 The Students' Completed Games

In this chapter, we will explain the games played by the students and analyze these games in view of international relations theories.

3.1 The First Play of the Game by Students

This simulation was a role-playing game in which each student played an actor: Japan, China, or the United States. Each player responded to the other states and calculated its points on each turn. Finally, each player's points were compared during the final stage, and then it was decided which state had won.

In the first round, Japan arrested the captain and his crew, and China demanded their release. Japan prosecuted the captain and never released him until the third round. China imposed economic, cultural, and diplomatic sanctions against Japan as countermeasures and demanded that the crew not be prosecuted again. China also detained four Japanese businesspersons on suspicion of spying.

At a US–Japan summit meeting at the General Assembly Meeting of the United Nations in New York, Japan demanded a US–Japan joint declaration by the United States that the Senkaku Islands were included in the area covered by the US–Japan Security Treaty, and the United States promised to take the appropriate steps. In the Japan–China negotiations, Japan requested the attendance of Chinese President Hu Jintao at the APEC summit held in Yokohama. China replied that Japan must be willing to release the captain and his crew; if not willing, China would impose further sanctions on Japan. Both Japan and China had not made promises then, and their requests were parallel. They faced the same situation during the secret negotiations. Japan desired to exchange the Chinese captain for the Japanese businesspersons who were detained in China. China replied and demanded again not only the release of the captain and his crew but also the discontinuation of the inspection of the Senkaku Islands by Mr. Nakaima, the governor of Okinawa Prefecture, as well as a declaration of nondisclosure for the video that depicted the attack on the Japanese Coast Guard by the Chinese fishing boat.

This meant that Japan would not diminish its point by releasing the captain and his crew. In contrast to Japan, because China had failed to release the captain and his crew, China also failed to prove its position at that phase. At this point, China's diplomatic and political options were restricted. At last, in the Policy Development phase, Japan avoided a strict promise. China was disappointed; therefore, China decided and declared not to end the sanctions.

The diplomatic negotiations continued with the Japan–China negotiation phase in the fourth round and the Hawaii and Hanoi summits in the fifth round. In all of the phases, Japan demanded the release of the businesspersons and an end to the sanctions, while China insisted on the release of the captain and his crew. In the Hawaii summit meeting between Japan and the United States, the United States declared again that the Senkaku Islands were included in the area covered by the US–Japan Security Treaty. After the declaration, China had no other diplomatic or political options. Although Japan eventually failed to be visited by President Hu at APEC in Yokohama, the Japanese point total was +31 and the Chinese point total was −35, and thus Japan won. This was quite a different outcome from the historical reality.

3.2 Follow-Up Meeting with the Students and the Second Game

In the follow-up meeting, two main opinions were pointed out by the players. Student A, who played as China, said that the players of this game were only political actors, so Japan could lead the game because of the arrest of the captain and other crew members. China could only use sanctions as a diplomatic card, so this was not a favorable condition for China. Student B pointed out the important role of economic actors. To improve the game, it would be necessary to introduce economic actors and economic factors into the game. The other opinion was that the United States in this game was a one-sided actor, which was unfair to China, and that the United States could declare the "alliance card" many times. For the game to become realistic, restricting the frequency it could be declared was important and necessary.

Student C pointed out that the economic dimension is important because almost all states, including Japan and China, are part of the worldwide system of economic interdependence. None of the states can stand alone. If a dispute should happen and the current economic situation should end, the economy should be damaged not for one state but for both states because of their interdependence. Thus, the game should have introduced the economic factor of interdependence.

Following the discussions, the rules of the game were revised. First, to maintain continuity and lift up the political thresholds (the condition of the gameover) of each side, a censure motion against the Japanese Prime Minister being adopted in the Diet would automatically result in −40 points, while the downfall of the Chinese political threshold would automatically result in −50 points. Second, China could impose diplomatic, economic, and cultural sanctions as countermeasures against Japan. In the first game, these sanctions were imposed at the same time, but their sanctions could be chosen separately under the new rules. The choices were not only sanctions but also included the restriction of Japanese businesspersons. Third, the US–Japan joint declaration of the area covered by the US–Japan Security Treaty could be made only once during the game and only at the Hawaii meeting. Furthermore, to introduce the dimension of economic interdependence to the game, if both states refused to compromise, their points would decrease every round.

The game was short the second time. Although it proceeded with the same situation as the first game until the Hawaii summit, it suddenly finished at that time. The Japanese government kept the captain detained, and China's points kept decreasing. Finally, at the Hawaii summit, the United States declared the application of the Security Treaty over the islands, and then China's points dropped to −50. In the second game, China lost again.

3.3 Analysis from the Perspective of International Relations Theory

This incident took place in the East China Sea between Japan and the People's Republic of China. Unlike the recent European continent, East Asia has been under the Cold War. There have been many conflicts between China, the Philippines, and Vietnam, not only in the East China Sea but also in the South China Sea, along what is called the "Nine-Dotted Line." Because of the similar international situations in the East China Sea and the South China Sea, this case has universal applicability to the East and Southeast Asian states.

Constructivists such as Karl Deutsch, Emanuel Adler, and Michael N. Barnett have pointed out that the security community structure on the European continent and all states that contribute to European regional organizations, including the North Atlantic Treaty Organization (NATO), the European Union (EU), the Council of Europe, and the Organization for Security and Co-operation in Europe (OSCE), prevents many incidents by following certain norms (Adler and Barnett 1998). Each state can imagine other states' behaviors easily. A game that is played by European states is not a game with imperfect information, since they can solve disputes under certain norms (Switky 2004).[3]

Therefore, under circumstances in which norms are shared by actors, the possibility of solving these conflicts will increase because conflicts tend to arise over means, not values.[4] Also, in the OSCE, all ambassadors attend Permanent Council meetings in Vienna once a week, so even if a conflict happens, all participating states can contact other states easily. This is a kind of confidence-building measure (CBM) that helps European states solve their conflicts easily.

In the Asian region, there is no comprehensive security mechanism or security community; instead, there are only hub-and-spoke systems like the United States and Japan, the United States and South Korea, and China and North Korea.

Under this regime, these states have no common understanding about conflicts and do not share norms. If a certain conflict happens, it becomes a conflict about values-6 and tends to last longer.

In this simulation game, both Japan and China were pursued to promote their national interests to the maximum. In this situation, both state had few incentives to compromise on the conflict, and they failed to reach an agreement to solve the conflict. Because the damage to China if it compromised with Japan would be relatively high and the only card China had was to restrict Japanese businesspersons on suspicion of spying, they had no possibility of winning by compromising with Japan.

In Asia, there are no organizations that hold regular meetings like the OSCE, and there are limited chances for nations to keep in touch with each other. Thus, it is difficult for both Japan and China to predict the actions and reactions of other states and difficult to agree on an optimal solution for both Japan and China. This situation is called a prisoner's dilemma. Because of this situation, diplomatic relations between Japan and China are not plus-sum relations but zero-sum relations, as this game showed. Figure 1 shows such a prisoner's dilemma in this game. For Japan, to release the Chinese captain and his crew is X1, and to not release them is X2. For China, to release Japanese businesspersons is Y1, and to not release them is Y2. The most preferred situation for Japan was for the Japanese businesspersons to be released and the Chinese captain and his crew not to be released. The worst case for Japan was the opposite of the most preferred situation. For China, in contrast to Japan, for the Chinese captain to be released and the Japanese businesspersons not to be released was the best situation, while the worst situation was the best situation of Japan. For Japan, the ranking from the best situation to the worst situation is as follows: X2–Y1 > X1–Y1 > X2–Y2 > X1–Y2. For China, these situations are as

[3] For a simulation game of the European Union, see Switky, B. (2004). The importance of voting in international organizations: Simulating the case of European Union, *International Studies Perspectives*, *5*, 40–49.

[4] Rittberger, V., & Zurn, M. (1990). Towards regulated anarchy in East–West relations: Causes and consequences of East–West regimes. In V. Rittberger (Ed.), *International Regimes in East–West Politics*. London: Pinter Publishers. Although Rittberger and Zurn argued about human rights regimes, the logic can be extended to security issues.

		Japan	
		Release the Chinese captain and his crew X1	Not release the Chinese captain and his crew X2
China	Release the Japanese businesspersons Y1	3 3	1 4
	Not release the Japanese businesspersons Y2	1 4	2 2

Fig. 1 Preferences of Japan and China

follows: X1–Y2 > X1–Y1 > X2–Y2 > X2–Y1. This figure shows that the best solution for both states is X1–Y1. In this game, however, both states chose X2–Y2 because neither state had any intention of compromising with the other state.[6] Negotiation between Japan and North Korea is one typical example.

Kenneth Waltz (1959) pointed out exactly that international disputes were reflective of the internal structures of states. In this game, the Chinese government could not compromise with Japan because the legitimacy of the Chinese communist government's governance partly depends on the nationalism of the people. Although it is not enough to think about this element in this game, the Chinese government had a strong attitude toward Japan because of its win.

4 Conclusion

This scenario is based on a historical incident that occurred between Japan and China. The Senkaku Islands have been a focal point of national security for both Japan and China. This accident was not only an attack by a fishing boat on the JCG; in both states, this incident challenged the government's reputation, which is why one government could not compromise with the other. In reality, the Japanese government released the captain and his crew, as demanded by the Chinese government. The game, however, was quite different from the historical reality; therefore, we have to follow up the rules of this game to approach real politics.

This game was not a reiterative game for the future. The players only have to think of winning, not the long-term consequences. The results of the game can be understood by neorealism theory. In real history, however, Japan and China reached a compromise, and they reached X1–Y1 in Fig. 1. A hypothesis in terms of neoliberal institutionalism theory is that the liability was carried by both Japan and China during the incident, and economic interdependence affected both Japan and China. If the incident had dissolved, the economies of both China and Japan would have been damaged, so they chose to compromise.

Many territorial disputes have existed in East and Southeast Asian states. Generally speaking, many diplomatic negotiations are what we call quiet diplomacy, and these negotiations about ongoing disputes or issues cannot be seen by people. This simulation game led students to understand the history of international diplomacy and politics more easily.

References

Adler, E., & Barnett, M. (Eds.). (1998). *Security communities*. Cambridge: Cambridge University Press.

Bothe, M., Ronzitti, N., & Rosas, A. (Eds.). (1997). *The OSCE in the maintenance of peace and security: Conflict prevention, crisis management, and peaceful settlement of disputes*. The Hague: Martinus Nijhoff.

Hermann, M. G. (1989). Inside the "black box": Decision making and foreign policy. In J. R. Kruzel & J. N. Rosenau (Eds.), *Journeys through world politics: Autobiographical reflections of thirty-four academic travelers* (pp. 365–380). Lexington: Lexington.

Hermann, C. F., & Hermann, M. G. (1967). An attempt to simulate the outbreak of World War I. *American Political Science Review, 61*, 400–416.

Loggins, J. A. (2009). Simulating the foreign policy decision-making process in the undergraduate classroom. *Political Science & Politics, 20*(2), 4011–4407.

Mandel, R. (1987). An evaluation of the "balance of power" simulation. *The Journal of Conflict Resolution, 31*(2), 333–345.

Mcintosh, D. (2001). The uses and limits of the Model United Nations in an international relations classroom. *International Studies Perspectives, 2*, 269–280.

Okano, T. (2006). Rule genereito gata simulation game no teian to taiken session. [Proposal for rule generating–type simulation game and game play session]. *Proceedings of the 2006 JASAG spring conference 2006*.

Rittberger, V., & Zurn, M. (1990). Towards regulated anarchy in East–West relations: Causes and consequences of East–West regimes. In V. Rittberger (Ed.), *International regimes in East–West politics* (pp. 9–63). London: Pinter Publishers.

Switky, B. (2004). The importance of voting in international organizations: Simulating the case of European Union. *International Studies Perspectives, 5*, 40–49.

Waltz, K. (1959). *Man, the state and war: A theoretical analysis*. New York: Columbia University Press.

Wendt, A. (1992). Anarchy is what states make of it: The social construction of power politics. *International Organization, 46*(2), 391–425.

Gamification in Education: "American Dream" Game

Anna Pikos and Tomasz Olejniczak

Abstract This article presents the results of an experiment involving gamification of "Principles of Management" classes conducted at Kozminski University in the winter semester of the 2014/2015 academic year. We found that although gamification gave mixed quantitative results in terms of final grades, it produced very positive qualitative results, which were visible in students' behaviors.

Keywords Gamification • Undergraduate studies • Management • Game • Education

1 Introduction

This article presents the results of an experiment involving gamification of "Principles of Management" workshops conducted at Kozminski University in the winter semester of the 2014/2015 academic year. The goal of the gamification was to increase students' participation and engagement in classes, to motivate students to read literature recommended after each class, and to increase the activity of students in the class.

2 Literature Review

Higher education is facing many problems nowadays. One of these problems is Generation Z storing the colleges and universities now. Generation Z or Millennials (Howe and Strauss 2007; Horovitz 2012; Bíró 2014) have a different approach to communication and learning. Social media and the Internet are often an important part of their daily lives and the process of socialization with others. They tend to rely more on the network to provide knowledge and advise them to possess knowledge themselves. Another problem is that Generation Z has a very short

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attention span, which is a very important aspect in the academic learning process based on the traditional methods of teaching and on students paying attention. One of the ways to address the current challenges in higher education is using a gamification approach to design the learning experience and process. “Gamification” is the use of game elements in nongaming systems to improve user experience and user engagement, loyalty, and fun (Deterding et al. 2011).

Educational systems face a major problem concerning student engagement (Lee and Hammer 2011; Dicheva et al. 2015). In contrast, we can observe a huge engagement in video games and virtual worlds (Deterding et al. 2011). For example, *28 million people harvest their crops in Farmville on a daily basis and over 5 million people play World of Warcraft for more than 40 h per week* (Lee and Hammer 2011). Literature records that the default environment of school often results in disengagement, cheating, learned helplessness, and dropping out. Most students would not describe classroom-based activities in school as playful experiences. The school’s rules have not only formal but also emotional and social impact on its participants (Lee and Hammer 2011).

Educators discovered that using game dynamics can increase student motivation and achievement in the classroom (Stott and Neustaedter 2013). Gamification borrows elements and techniques from different areas like games, play, behavioral science, and motivation, using it in nongame contexts (Herger 2014; Stott and Neustaedter 2013; O’Donovan et al. 2013; Lee and Hammer 2011). It is based on observations of players’ behaviors and game structures. Gamification combines the work at hand with reward-based design aspects of games to create a product that is enjoyable and motivating (Kapp 2012). The rules of the game are complex and can be explored through active experimentation and discovery (Lee and Hammer 2011). Games provide emotional experiences from curiosity to frustration to joy (Lazzaro 2004). Moreover in a social aspect, they allow players to try on new identities and roles (Lee and Hammer 2011).

It has been applied in social contexts, in businesses, and in competitions to motivate participation (O’Donovan et al. 2013). According to O’Donovan, a *game needs to be motivating, addictive and encouraging with very short-term goals so that one can fail and try again until one succeeds*. In a game, even repetitive tasks can be attractive and entertaining (O’Donovan et al. 2013).

3 Methods

Gamification was conducted in the form of an experiment in the “Principles of Management” class in the winter semester of 2014/2015 academic year. Experiments were conducted in parallel both on Polish and English track programs. Each of the authors conducted classes in two different groups of students on either Polish or English programs. One group was randomly chosen to be an experimental group in which gamification methods were introduced. The other one was a control group in which classes were conducted in the same way as in previous years. Each group of students was of the same size (approx. 30 people). All activities and subjects were taught in the same manner, using the same resources, and were consistent with the course syllabi.

Data collection included direct observations, Excel sheets with points for students' attendance, participation, and homework assignments as well as researchers' diaries kept throughout the experiment. Both researchers consulted each other concerning the details of lectures and class management to achieve the highest rate of consistency between Polish and English track classes.

The game introduced in the experimental group was entitled the "American Dream." Students assumed the roles of the first immigrants to the United States in the early twentieth century looking for ways to earn money and develop their own businesses. The lecturer assumed a role of a "Great Investor," a wealthy banker assigning missions and providing individual game players with necessary capital. The main aim of the game was to gather as much capital as possible and to develop the biggest factory.

To begin development of the factory, participants were required to establish a three-person company. Each company had to be registered by the Great Investor and received a certificate confirming its registration. The Great Investor assumed a role of an advisor providing participants with basic knowledge concerning management during regular meetings. The currency used during the game was US dollars with the picture of the Great Investor. Money was kept in the silver suitcase and participants received payouts at each class. During each meeting, participants had a chance to earn money for themselves and for their companies. Opportunities to earn money included:

- Missions from the Great Investor (i.e., homework) in each class for $30 ($600 in total)
- Expertise for the Great Investor (i.e., group presentation and report on one of the subjects) – $900
- The Great Depression (i.e., theoretical test) – $750
- Spying mission (case study solved in groups) – $750

Participants received regular feedback concerning their performance both at the individual level and at the level of individual companies. Both types of results were presented in the form of leaderboards. Summary methods used in the game are presented in Table 1.

In the control group, all classes were conducted in the same order and manner. The main differences included lack of regular feedback after each class, lack of three-person groups, and lack of consistent plot and that participants received points instead of money.

After the experiment, each group of students on both English and Polish tracks was provided with a questionnaire to assess the content of the class.

Table 1 Summary of gamification mechanisms used and what they looked like in class (own work)

Game mechanics	Aim of the mechanics	Examples
Immediate feedback	Feedback is a key and critical element in learning. The more frequent and targeted the feedback, the more effective is the learning (Kapp 2012). It is important for individuals to track the progress (Herger 2014; Zichermann and Cunningham 2011)	After a class, students received information directly from the Great Investor on the work they have done so far. Furthermore, additional reinforcement followed in the form of prizes
Money	The design of the reward system should maximize user enjoyment. The progression from one level/badge/star to the next cannot be easy (O'Donovan et al. 2013)	The amount of accumulated capital shows the student's level of involvement in the work of the classes
Two levels of competition	Competition is added to increase engagement for students (Zichermann and Cunningham 2011)	The first level focused on the performance of individual participants; the second showed the results of established companies. Two levels of competition increased motivation for coming to class. When a colleague from the company did not participate in the classes, the whole group was losing capital
Leaderboards	Leaderboards allow students to view their achievements compared to others in the same class (Zichermann and Cunningham 2011). They also create a sense of belonging to a similar minded group and competition among them (O'Donovan et al. 2013)	Visualization of accumulated capital of individual students. This was a point of reference for a student (as well as how he/she is doing, how much money has yet to be earned to be number 1) Visualization of the capital accumulated by the company (how well the company compares to other established companies)
Short missions	Missions support students by organizing information into categories to focus their attention (Benson 1997)	Focused attention on the student's knowledge and skills that should be purchased within individual classes
Time restrictions	Time limit prevents the accumulation of tasks for the "last minute"	Students always have appointed time, which does the job
Storytelling	Literature records that people learn facts better when the facts are embedded in a story rather than in a bulleted list (Kapp 2012)	It made the content more attractive and provided a consistent plot, motivating participants to achieve the objective of the course by bringing the plot to an end (Deterding 2012). The story was also binding outside the classroom; participants were required to call the lecturer the "Great Investor"
Badge of honor	Gamers may enjoy the external rewards they receive when they succeed in a game	Students were awarded the final grade at the end of the course. Moreover, the best students (the first three places) and the best factory received additional prizes

Table 2 Results from the class (own work)

		Test (out of 25)	Case study (out of 25)	Homeworks (out of 12)	Absences (out of 15)	Final result (out of 100)	Final grade	Passed	Exam results
English track	Control group ($N = 26$)	8.04	15.19	5.77	3.15	64.04	3.35	21	3.03
	Experimental group (**$N = 24$**)	**11.38**	**15.88**	**8.21**	**1.67**	**72.88**	**3.69**	**23**	**3.10**
Polish track	Control group ($N = 20$)	7.04	18.79	2.25	3.0	58.05	3.35	11	3.65
	Experimental group (**$N = 19$**)	**12.58**	**19.30**	**7.79**	**1.42**	**76.00**	**2.82**	**19**	**3.74**

4 Results

4.1 Quantitative Results

Quantitative results included the results from each activity conducted during class, such as theoretical tests, case studies, homework, and absences along with the final results. Additional indicators were the number of people who passed the workshop and were permitted to take the oral exam from the "Principles of Management" lecture conducted in parallel to the workshops. We also monitored the results from the oral exam. Results for each group are presented in Table 2; dollars were converted into points (1 point = $30) for the sake of comparison between experimental and control groups.

Additional quantitative results were acquired from the questionnaire distributed in each group of students on both English and Polish tracks. Students from experimental and control groups were asked to assess the content of the class on the 7-point Likert scale. Additionally, students from the experimental group had to choose multiple elements they liked the most about the game. The results are provided in Tables 3 and 4.

4.2 Qualitative Results

Qualitative results included observations made during the class as well as feedback received from students in the final questionnaire.

The difference in the attitude of students was observable from the first class. During the presentation on the rules of the game, the participants in the experimental group exhibited great interest and asked a number of questions. In the control group, the passive attitude prevailed and participants were clearly bored. The atmosphere during the introduction had a huge impact on the rest of the class. While in the experimental group, the atmosphere was relaxed and proactive, fear and indecisiveness prevailed in the control group. In the experimental group, the majority of students were active, while activity was dominated by a few people in the control group.

These results were confirmed by the feedback provided by participants in the final questionnaires (Table 5).

A very interesting observation can be made about the effect of "exchange rate" between dollars and points in both groups. As mentioned earlier, 1 point = $30 so in the experimental group, participants received a relatively higher amount for the same task. This has been confirmed in the results of the survey in the answer "Unmotivation because max points of essay is just one point."

Table 3 Results of the questionnaire (7-point Likert scale)

		What is your overall opinion about the class?	This class helped me to achieve course learning objectives	The way in which class has been taught has motivated me to be active	This class has motivated me to do homework	This class has motivated me to read the suggested literature
English track	Control group ($N = 19$)	5.79	5.68	5.21	5.05	5.05
	Experimental group ($N = 15$)	**5.73**	**5.21**	**4.67**	**5.13**	**3.93**
Polish track	Control group ($N = 18$)	5.72	5.64	5.06	3.78	4.56
	Experimental group ($N = 19$)	**6.00**	**5.32**	**6.05**	**6.05**	**4.88**

Table 4 The best elements of the games (own work)

Element of the game	Number of answers (Polish track)	Number of answers (English track)
Changing the point scores into money	15	9
Cooperation among groups by members of established factories	8	4
Possibility of comparing your results with others using leaderboards	7	6
Quick feedback concerning results	6	7
Storytelling	6	6
Final prizes	4	0
Missions from the Great Investor	3	3

5 Conclusions

Although the quantitative results show mixed outcomes, especially between Polish and English track classes, the qualitative results provide more or less a consistent picture of increased motivation and engagement in the class.

The differences in quantitative results can be attributed to a number of factors such as the influences of the lecturer, the overall group dynamics and class times (classes in the morning/afternoon classes), and the effect of nationalities of the participants. More people from Western Europe were in the control group; almost all of them had the highest final scores).

However, the game resulted in a number of positive qualitative results. These included (1) a more friendly and open atmosphere in the experimental group; (2) social behaviors such as assistance to other group members building the same

Table 5 Students' comments (own work)

	What was the weakest point of the class/game?
Polish track (control group)	Too little time
	Short course
	Assignments in the session
	A difficult task at the end of the course
	There was no such points
Polish track (experimental group)	I do not know
	Not enough time to gain income
	The Great Depression
	It is difficult to adequately assess each work activity in the classroom in dollars
	The discrepancy between the different leaderboards was too big to do it in a well 100 proc
	Money for their presence, a large number of investor orders that were sometimes difficult to manage
English track (experimental group)	Everything was great!
	I think that everything was great
	I am fully satisfied with all issues of the game
	There was almost no motivation of cooperation among group members of factories. All I felt was I should get as much money as possible. But this is for my grade and nothing else
	The idea of getting money is good, but you should also be able to invest it (work with your money); otherwise, it makes not much sense
	There should be more side opportunities to earn extra money
	Waiting for one money after classes has always shortened our breakfast break significantly
	Payment method – it should be more organized next time
	To get 3 you need too much money; waiting for money after class
	Having to collect money and waiting after class to get them
English track (control group)	Difficult to understand some topics
	The subject itself can be pretty complicated. Maybe more real-life examples need to be provided by teacher to understand theories better
	I liked the teacher, but I do not understand the aim of the management course. Perhaps I need some real-life theories and examples, which I can use in life
	Unmotivation because max points of essay is just 1 point
	Unmotivation because max points of essay is just 1 point
	I do not know
	Sometimes our workshops were quite boring; however I've tried to find it interesting
	All good
	I would like more examples in real life
	No weaknesses

(continued)

Table 5 (continued)

	What was the weakest point of the class/game?
	Homework cost 1 point, no bonus for big comment in the homework
	Everything was clear. Thanks to our BEST TEACHER
	No idea
	Sometimes it was hard to understand something, but in general I'm satisfied with our classes

factory; (3) multiple questions about the opportunity to gain extra money or points; and (4) peer pressure, when participants in the experimental group motivate each other to come to the last class where there was a case study.

To sum up, the "American Dream" game has served its purpose of raising motivation and engagement by using the elements of gamification. These included (1) conversion of standard forms of homework into a series of short tasks related to the topic of the next class, (2) conversion of standard forms of knowledge test (solving a case study) into elements of the game, (3) providing consistence involving a plot throughout the class, and (4) replacement of the classical system of assessments with the monetary system.

At the same time, participants' comments suggest that there is still some room for improvements including elements such as (1) better organization of payments, possibility using an online application that would provide participants with the ability to invest accumulated capital; (2) an even closer link with the reading homework manual; (3) a clearer final reward system; and (4) more emphasis on the benefits of cooperation within the group.

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References

Benson, B. K. (1997). Coming to terms: Scaffolding. *The English Journal, 86*(7), 126–127.

Bíró, G. I. (2014). Didactics 2.0: A pedagogical analysis of gamification theory from a comparative perspective with a special view to the components of learning. *Procedia – Social and Behavioral Sciences, 141*, 148–151.

Deterding, S. (2012, July). Gamification: Designing for motivation. *Interactions, 19,* 14–17.

Deterding, S., Khaled, R., Nacke, L. E., & Dixon, D. (2011). *Gamification: Toward a definition*. Paper presented at the CHI 2011 gamification workshop proceedings, Vancouver, BC, Canada. Retrieved Mar 24, 2015, from http://hci.usask.ca/publications/view.php?id=219

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society, 18*(3), 75–88.

Herger, M. (2014). *Enterprise gamification. Engaging people by letting them have fun*. Lexington: Enterprise Gamification Corp.

Horovitz, B. (2012, May). After Gen X, millennials, what should next generation be? *USA Today*. Retrived from: http://usatoday30.usatoday.com/money/advertising/story/2012-05-03/naming-the-next-generation/54737518/1.

Howe, N., & Strauss, W. (2007). *Millennials go to college* (2nd ed.). Great Falls: LifeCourse Associates.

Kapp, K. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. San Francisco: Pfeiffer.

Lazzaro, N. (2004). *Why we play games: Four keys to more emotion without story*. Retrieved from: http://www.xeodesign.com/xeodesign_whyweplaygames.pdf

Lee, J., & Hammer, J. (2011). Gamification in education: What, how, why bother?. *Academic Exchange Quarterly*, *15*(2), 1–5.

O'Donovan S., Gain J., & Marais P. (2013). A case study in the gamification of a university-level games development course. In P. Machanick, & M. Tsietsi (Eds.), *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference (SAICSIT '13)* (pp. 242–251). New York: ACM.

Stott, A., & Neustaedter, C. (2013). *Analysis of gamification in education (Technical report 2013-0422-01)* (p. 8). Surrey: Connections Lab, Simon Fraser University. Retrieved from http://carmster.com/clab/uploads/Main/Stott-Gamification.pdf

Zichermann, G., & Cunningham, C. (2011). *Gamification by design*. Sebastopol: O'Reilly Media Inc.

Part III
Business Fields

Japanese Creative Service and Its Competitive Value Co-creation Processes

Yoshinori Hara

Abstract In this chapter, the concept and the characteristics of the Japanese Creative Services are described. They are defined as Japanese value-added services influenced by such contexts as natural, cultural, historical, and/or lifestyle factors. They typically have anecdotal values based on nature, traditional culture, histories, and/or lifestyles. They also have an *Omotenashi* mind-set as an essence of Japanese hospitality and a framework to evaluate and inherit their service competence. It also explains about the competitive value co-creation processes for the Japanese Creative Services. We believe that these kinds of value co-creation processes will contribute to creating new values in the field of service science toward the sustainable global services.

1 Japanese Creative Services

As shown in Fig. 1, we define creative services as highly contextual (Chandler and Vargo 2011; Hara et al. 2012; Kobayashi et al. 2014), value-added services with influences of natural, cultural, historical, and/or factors that influence the person's lifestyle. Creative services have more added values than the values only coming from their primary functional capabilities. For example, as for an automobile, the primary function is for a person to move from one place to another. However, the total value of the automobile is not just such primary value. There are the added values of design, customer experience, story, brand, relationship, etc. in addition to the core service values.

Japanese Creative Service is a creative service where their added values are created from the association between the service itself and the Japanese context. Japan has a traditional way of viewing its four seasons, a unique history and culture, and various dialects that influence the people's way of thinking. In this regard, we select the following four fields as a typical Japanese Creative Service. They are

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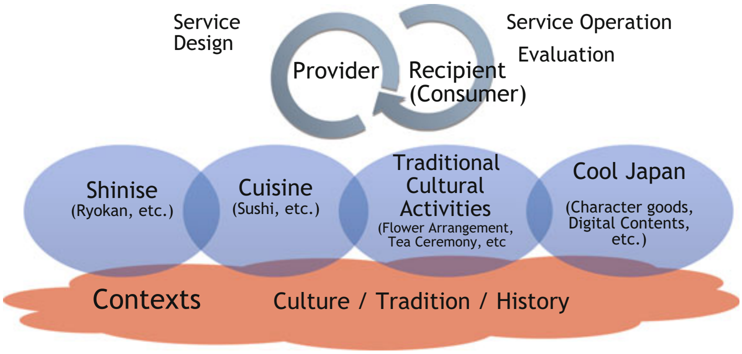

Fig. 1 A framework of Japanese creative service

Shinise companies, Japanese food services, Japanese cultural activities, and *Cool Japan*.

2 *Omotenashi* in the Context of Japanese Creative Services

Omotenashi is a conceptual word that explains a typical Japanese hospitality. The original meaning of *Omotenashi* was an attitude of treating guests; on the contrary it may or may not be a good attitude. However, the current meaning of the word has been shifted more toward the positive side. In particular, the word *Omotenashi* is used to respect others from their points of view, in order to let them have better experiences.

In order to perform *Omotenashi*, it is important for a service provider not to be recognized on what he or she intended to do by the service recipients. Japanese people have culturally understood these kinds of processes as invaluable. We think it is more valuable to sense the contextual information for guessing what others want and to perform services to fit their ideal, rather than to intentionally perform services that are recognized by the service recipients (Hall 1976).

This is a quite different mind-set compared to the US style of hospitality where its value creation process is for service providers to provide services intentionally to surpass their service recipients' expectations. According to the experimental studies (Grönroos 2000; Hofstede 1984), Japanese people feel satisfied more on familiarity in terms of service value creation, while US people feel satisfied more on novelty.

Another important aspect of *Omotenashi* is a two-way awareness process between the service provider and the service recipient. As mentioned above, the service provider provides *Omotenashi* without any explicit intentions to the service recipient. However, this *Omotenashi* process implicitly presumes the awareness to the services by the service recipient. Unless the service receiver recognizes the service, the value of the service is not revealed. Therefore, consumer literacy to recognize such service values is important and indispensable. Once it is revealed, the value of the service is highly qualified and sustainable.

Further, the values of *Omotenashi* are not designed for the service recipients only but also for the service providers by themselves. For example, the service value for the tea ceremony is not intended to the guests only but also to the tea ceremony organizer. As a Japanese proverb "70 % of the service value is for the tea ceremony master, and the other 30 % is for the guests" says, the service providers feel more comfortable recognizing with the situation that their guests have felt the same way toward the tea ceremony. This process to create the value of service is also a unique feature of Japanese Creative Services.

Furthermore, the *Omotenashi* interaction process is also dependent on time, the location, and the people that are involved. It may be difficult to duplicate such services efficiently, since it is a labor-intensive, time-consuming work. Therefore, the productivity of Japanese service sectors is generally low. However, as a consequent, the quality of the Japanese Creative Services is high enough to sustain their businesses.

3 Competitive Value Co-creation Patterns Inside of *Omotenashi*

In this section, let us focus on the value co-creation patterns with the service provider and the service recipient (consumer) (Prahalad and Ramaswamy 2000, 2004). It can be viewed as the communication process between the service provider and the service recipient.

Compared with goods, the value of the service is not always perceived by the same perceptions simply because the quality of the service delivered by the provider should be the same. It is also influenced by the physical evidence and other recipients' behavior. That is, the value of the service can be produced by the interaction between the service providers and the consumers (Grönroos 2000).

We will place emphasis on and examine the concrete examples in the Japanese Creative Services, to find hints into how it could be considered inside the scope of *Omotenashi* inside a scientific approach. We will consider the service with *Omotenashi* as a service that works upon a communication (value co-creation) set upon the sender (service provider) and the recipient (customer) and work to organize the factors that could be related back to value co-creation.

When compared to objects, service takes a different step around. Even if the provider provides the same product with the same attributes, it does not always mean that the customer would find the exact same values inside the product itself. Also, the value of the service is determined not only by the elements of the customer but also on the physical environment and how the other customers react toward it. In other words, the value of a service is created by a dual function between the provider and the customer (Grönroos 2000), and it could be separated from aspects such as the value of the object itself, which is attributed to how the object is depicted inside the various forms of media. When we look at this from a closer view, the factors acting upon the customer to change their state, which is formed by the interaction with the service provider, create what we would call service value.

When we derive this dual function for value creation (a cooperative value creation) processing as communication, the information that has to be transmitted can be divided into a tacit or explicit way of providing the necessary elements related to that cause. In this regard, the tacit way of providing information is seen based on individual interactions or a nonverbal interaction which does not always need to relate to verbal behavior. This takes a form which relates to factors such as physical movements or spacing to derive the mental state or intention that the other person is holding or to pose your own intentions through an indirect way. On the other hand, the explicit way of providing information is done through a form that involves a direct verbal interaction to put forth one's ideas. Once this is done, we could look through the situation through the two scopes, of whether it is done through an explicit or tacit way or if the information interaction for the recipient was done is an explicit or tacit manner. We would then group those ideas into the four communication patterns for value co-creation that are mentioned below (Kobayashi et al. 2014). What we have to be careful at this point is that we should not question the fact that we cannot be sure if both the service provider and the customer are sending out information from their will (tacit) or if they are not sure of the fact that they are sending out information (explicit).

– *The Manifestation type*: A value co-creation process that relies on both the service provider and the customer explicitly
– *The "Omonpakari (awareness)" type:* A value co-creation process in which the provider reads through the tacit psychological state of the customer and gives out value
– *The "Mitate (visualization)" type*: A value co-creation process in which the provider expresses their notions through nonverbal behavior, which lets the recipient decide on the intentions behind the behavior, which leads to hint at the ambiguity in those sequences
– *The "Suriawase (dialectic)" type*: A value co-creation process in which both the provider and recipient go through an implicit information exchange and therefore place emphasis on both factors to create a higher service value.

In understanding *Omotenashi*, we would have had to look through the idea of what "makes" it, and what it "does," or in other words, the means of reception and means of action. The problem here was that the means of reception was still undecided. Therefore, in order to proceed with the resourceful essence of *Omotenashi*, there would have to be a selection of information from the wide variety of background information and environments, to see through the idea and fill in the blanks of who does what in order to create a value mechanism.

When we see through these four value co-creation models in detail, we can see that these models have a pattern in how it is "made" and how it is "done" and that it creates an adaption field. In other words, it creates a regulation which refines the

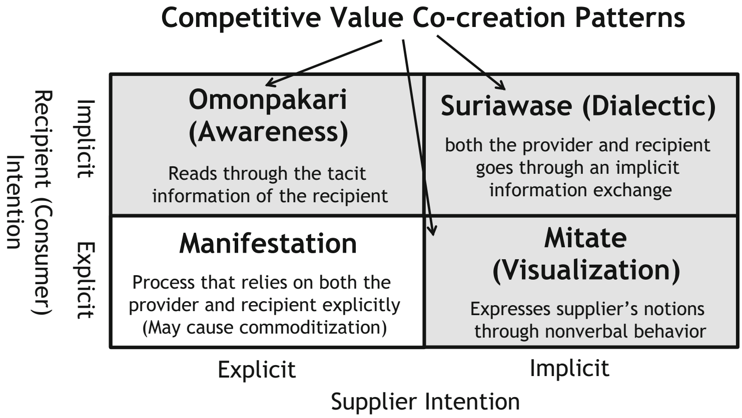

Fig. 2 Competitive value co-creation patterns inside of *Omotenashi*

precise information from a vast amount of information. From this point onwards, we will look at the difference between these four value co-creation patterns (Fig. 2).

3.1 Value Co-creation by the Manifestation Type

In the value co-creation process done by the Manifestation type, the interaction of intentions between the service provider and the consumer who take part in the conversation can be seen as Manifestation shown in Fig. 3. So if we could specify the ways in how the process is "made" and is "done" in advance, we could make a more efficient and effective value co-creation model.

In the Manifestation value co-creation process, the consumer shifts or adapts the service in order to fit their needs, so it becomes important that the consumer has access to the right information, knowledge, and skills and has the expertise to utilize it. Vargo mentions that the consumer has to act accordingly with the needs, circumstances, and actions when learning how to use the resources and learn to make adjustments or adaptations to maintain its value (Vargo and Lusch 2004, 2006). Payne also mentions that the service provider has to place the consumer's resources (knowledge or skills) alongside their resources and then make an offering process so that the consumer themselves can utilize the resources in an efficient and effective manner (Payne et al. 2008).

Recently, in the value co-creation by the Manifestation type, anyone can join the value co-creation process, so the use of IT (information technology) to contact customers has given rise to a new type of innovation, as mentioned by Chesbrough (2011). To give out some examples of how a customer joins in the provider's process, the online tracking system done by FedEx in checking its shipments and deliveries, the express reservation system for the Shinkansen (bullet train), and the self-check in system done by the conveyor belt sushi chains can be named. These all

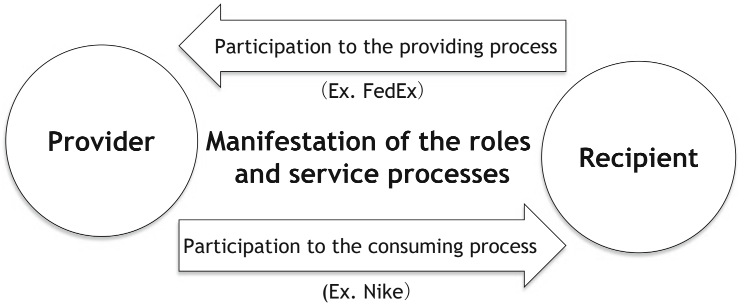

Fig. 3 Value co-creation by the Manifestation type

involve an order which is done by the customers in advance, and the way that they can check up on their situation is realized by the use of IT. In other words, the use of IT through the customer contacts can lead to efficient service processes and a rise in attributes, where the customers can utilize their resources accordingly with their purposes, thus making this an important value co-creation model.

On the other hand, in model of when the provider joins in the customer's consumption process, there is an enhancement of value co-creation by the Manifestation type, done by the use of IT. For example, in the sports maker, Nike, they have created a service device that makes a linkage with the sneakers, so that the individuals can check up on their running data and also make comparisons with others. In other words, a service that had to be done by hands of the customers such as the exercising situation is how supported by a new service process that is designed to be set up by Nike. As a result, Nike has improved their customer expectancy and value in which the customers see the process of actually using the sneakers.

The merits seen by this value co-creation process is that a scale expansion of service as seen inside the franchise businesses such as fast food chains becomes possible if the duties and processes are manifested. On the contrary, a manifested process is vulnerable to conflict and has the risk of being easily manipulated.

So as a result, this model does not ensure the sustainability of a service and thus results in one factor that commodifies it. Another viewpoint is that this approach which balances out the expansion of service and sustainability has not been a keen target of discussion yet.

3.2 Value Co-creation Patterns with Japanese Creative Services

The Japanese Creative Services differ from the value co-creation from manifested communication in that it has the characteristic of dealing with a communication process where either the sender or recipient sends out an implicit message to the other. In such a value co-creation, both sides try to derive the intentions behind the other and try to build up a communication that can lead to understanding. Especially in Japan, there is a high probability of a context being formed not only from verbal interaction but from shared time and shared experiences. Some merits that come out of this is the joint community which “ate out of the same bowl,” which can sense each other’s feelings by mutual reasoning.

However, if that environment does not form, they cannot find a subject to start off a conversation, and they would feel uneasy not knowing what the other is trying to say through the dull interaction.

As shown in Fig. 4, in this type of communication, the provider side and customer side both get affected by the effects of the context. Furthermore, as seen in Fig. 5, a low-context communication-type service which takes a manifested co-creation process as well as an implicit co-creation process can be seen inside the high-context communication-type services.

3.3 Value Co-creation by the *Omonpakari* (Awareness) Type

The value co-creation by the *Omonpakari* type is one that does not inherently emphasize the fact that the provider is providing a service and is rather a way of providing the precise service while deriving the implicit notions and or psychological state of the customer (Fig. 6). *Omonpakari* is one element in understanding *Omotenashi*. The starting core for the value of the consideration type is that there is a place where the notions and or psychological state of the customer can be derived. By setting up such a field, we can look at “how the people use the service” and utilize a place where they could “derive the intentions and notions of the customer,” to smoothly transition into a “situation where the service could be appreciated.” This would have a standing of being an effective value-creating process that would

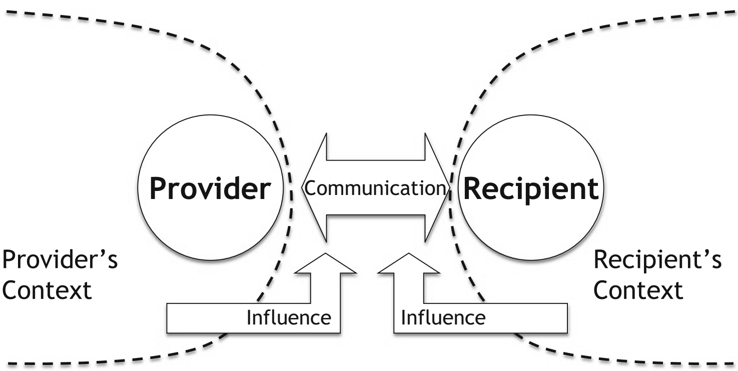

Fig. 4 Influences by contexts

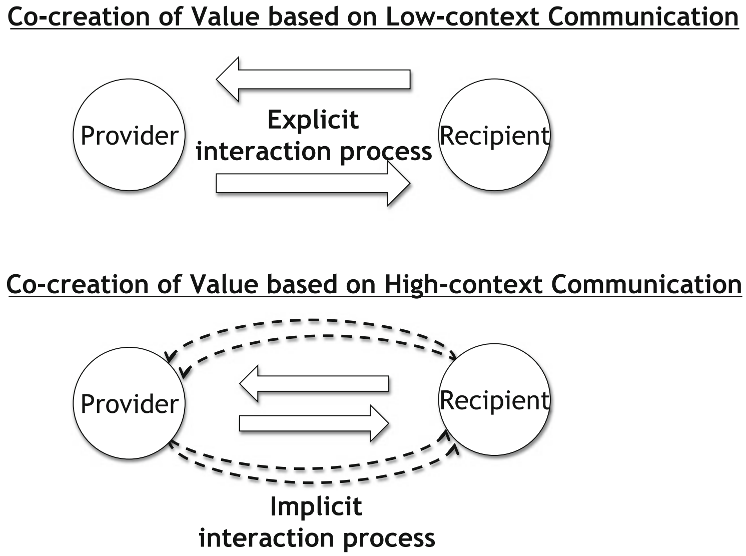

Fig. 5 Value co-creation patterns by the difference of contexts

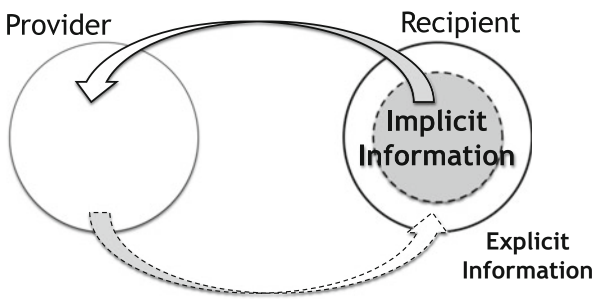

Fig. 6 Value co-creation by the *Omonpakari* (awareness) type

have effects such as a rise in the sustainability of the service or a positive influence on the relationships with customers and a rise in the production value.

To give a general example, the service based on communication interaction between a customer and a waitress, which is seen inside a Japanese cuisine, can be named. In the cuisines of long standing, a waitress senses the implicit notions from the customer's actions and is thought to build up an adequate field and then provide it depending on the situation, as an important matter. Some examples of this would be talking about the season or garden to ease the customer's stress. As a result of this type of *Omonpakari*, the customer does not only see the value inside the cuisine but gradually sees into the value seen inside the garden and details of the *Kakejiku* (hanging scroll) and see into the deep value seen inside the service. In other words, the value co-creation from the *Omonpakari* type is that a place where the provider even derives implicit information such as the psychological state and experiences of the customer is given and as a result can be seen as a value co-creation process that can deepen the customer's reception sensitivity toward the service around them.

We can place this type of value co-creation by *Omonpakari*, inside the terms of business development seen in businesses. One such model is seen in the PB (private branding) developed by 7-Eleven convenience store. The PB development does not sell products that are created from manufacturers, but it is rather a process that is led and created by the retailers which is backed with information gained from the retailing process.

If we place the PB development in the framework of the value co-creation process, it can be seen in the process of utilizing the POS (point of sales) information to build up a hypothesis about the implicit needs sought by the consumers and then work together with the manufacturers and material makers to build up a new product. Furthermore, by verifying the hypothesis of the PB products' selling situation by POS, it indirectly creates a value co-creation cycle between the provider and consumers. The strengths of this company in using this process are that it can look upon the implicit needs sought by the consumers by the enormous selling information from the stores and build up a hypothesis to improve the situation. The hypothesis verification is also shared with the makers as a quality standard, to create a value that cannot be created alone by manufacturing makers.

3.4 *Value Co-creation by the Mitate (Visualization) Type*

The value co-creation by *Mitate* is different from the *Omonpakari* type in that it takes an implicit process in how the provider provides their information (Fig. 7). *Mitate* can be seen as a communication tactic that involves utilizing objects' shapes or colors to convey an implicit intention toward the customers. For example, a communication at a tea ceremony involves the use of Japanese confectionery. It can express elements such as the wavering season from their color and shape, and in the tea ceremony, there is a communication that involves a process where the visitor looks at the confectionery to derive the provider's intention. To mention this point further, in the *Kado* (flower arrangement) house of *Ikenobo*, there is a family

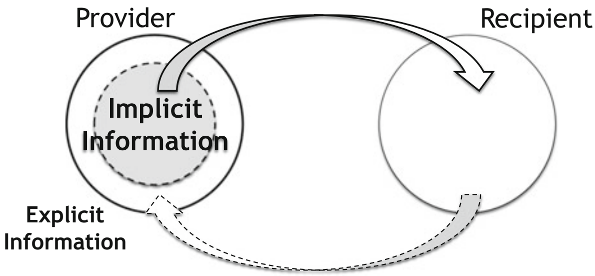

Fig. 7 Value co-creation by the *Mitate* (visualization) type

precept that says, "There is beauty even inside the withered flowers." The idea presses upon the factor that people shouldn't overly emphasize the outside decorations and is viewing the element of life through the flowers and signifying their importance. The expression and succession of value is proceeded through these diagnostic sequences.

This type of diagnosis is also one way to understand *Omotenashi*. The value expression core of this sort is seen in the way that a place is given to freely express your emotions and that it can be shown in an abstract manner. In creating this type of environment, the visionary sense (the use of colors and shapes) that leaves space for imagination, or the use of information to evoke the five senses, is utilized. By setting these environments, "the use of colors and shapes" leads to create an environment "where the provider's emotions can be abstractly seen through the optical senses," which results in promoting the idea of the "customer being able to understand, imagine, and enjoy trying to maneuver around the intentions behind the objects." By using *Mitate*, we could look through the utility seen by the optical effects that leaves space for imagination. From this framework, the customers are able to take a process of understanding and imagining the provider's intentions from their own perceptions and as a result deeply look into the service value. It can be taken as, a way in that the provider's implicit emotions are expressed abstractly on purpose, to create a value co-creation process in which the customer can use their creativity and enjoy interacting with the service around them.

From the various diagnosis-type value co-creation examples seen in businesses, Sanrio shows a unique stance. Sanrio proceeds with a business development that uses character licenses such as Hello Kitty, but it allows some altering to the design image to the licensees, resulting a cooperation with various content providers. In a normal license business, there is absolutely no right for a licensee to alter a character's design. However, in the example of Hello Kitty, there is a design that wears clothes from Sesame Street or a Kitty that sticks their tongue out from a cooperation with the rock band "KISS." By looking at this from a provider's perspective, we could see that the Kitty is diagnosing the implicit merits of the content, without reducing its brand image. As a result, the Kitty is taken as a "Cute" brand, and the customers could use their imagination to enjoy the service. Sanrio went over the primary boundaries of a character business for girls' toys and has globally set up a *Mitat*-type value co-creation that falls upon various businesses and business categories and is a business model that has succeeded with that endeavor.

3.5 Value Co-creation by the Suriawase (Dialectic) Type

The value co-creation by *Suriawase* is one that implicitly exchanges information between the provider and customer, to deepen the value of the service (Fig. 8). Some familiar examples include a communication sequence between a chef of a Sushi restaurant and his/her customer. At this setting, there is a sense of struggle in

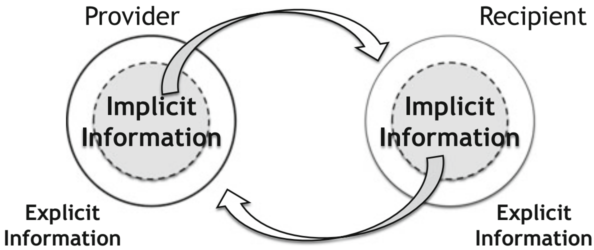

Fig. 8 Value co-creation by the *Suriawase* (dialectic) type

the atmosphere characterized not only by the food but by the conversation, actions, and/or facial expressions shown by the chef which deepens the service value as a result. It could be said that the service provider and customer express themselves and undergo a value co-creation in which they negotiate through an interaction with each other (Yamauchi and Hiramoto 2013).

These types of *Suriawase* are the same as *Omonpakari* and *Mitate*, in that it is one element in understanding about the components of *Omotenashi*. The value expression core of the *Suriawase* type is that there is a place to exchange the knowledge between the user and provider and as a result build up an environment that keeps the necessary struggle. By building this field, the use of "the conversation between the recipient and provider" would build up a place that "builds up and keeps the necessary struggle," which would lead to "deepen the service value not only toward the provider but also toward the recipient." From this, the *Suriawase*-type value co-creation is thought to be the most high leveled and deep value co-creation process seen inside the Japanese Creative Services. In this type, the recipients would also try to overreach themselves and endeavor to gain some experience of this sort. As a result, the recipient's sensitivity toward the service value, i.e., service literacy, would rise and would lead to precisely recognize the fundamental value of the service itself.

This model has yet to be organized into service businesses, but some challenges have already been made. For example, Sushi Kanesaka has already been in Singapore. In the aspect of the Japanese traditional cuisines going internationally, they keep the unchangeable assets that are passed down but recognize and move accordingly with the local food culture. This model is unique in that it needs to be low contextualized or the service has to take the form of being context free in order for it to become globalized, thus making it a one that is separated from the other conventional approaches.

To summarize our main points, we have looked into *Omotenashi* in order to realize its actions and effects, by utilizing the framework inside the model of creative services which have high added value and arranged and systematized the value co-creation processes inside them. We have mentioned about *what "makes" a situation and what it "does"* and the environment that forms it together in the idea of *Omotenashi* and explained about its effects, as shown in Fig. 2. This combines the conventional notions that a service provider's value providing stance and the customer needs would need to be explicit. That process started to place emphasis on the implicit notions to further widen and systematize the value co-creation process.

The value co-creation by the Manifestation type can be seen as the provider being a butler. The provider provides service based on the minutely orders placed by the customers. On the contrary, *Omonpakari* can be seen as a waitress in a Japanese cuisine (sees through and reads the customer's knowledge and habituation to support a smooth communication), *Mitate* can be seen as a teacher of tea ceremonies (uses seasonal confectionaries and a set environment to illustrate the fact that they welcome these customers), and *Suriawase* can be seen through the model of the owner of a renowned Sushi restaurant (the customer and the owner build up and keep a sense of struggle in the atmosphere, to evaluate each other to deepen the value of the discourse).

4 Sustainability and Scalability

One of the high priority issues of the modernized companies, particularly the companies in the US, would be to maximize the return on investment. That is, any company should be responsible for all corresponding stakeholders including stockholders to gain benefit from the company's operation. The company executives focus on their business growth and look into the criterion of scalability, profitability, efficiency, etc. to be the most important criteria in which to conduct businesses. As a consequence, maintaining sustainability would be the result of this process and not the primary objective.

On the contrary, executives of almost all *Shinise* companies state their objective as the sustainability of their companies. They are always concerned on how they can successfully transfer the businesses to their successors. They do not care too much about the growth of their company and look into the act of succession in more depth. To be more concise, the average company size would be smaller than that of the US companies. However, a significant amount of companies located in the same area coexist and conduct their long-standing businesses. This is an interesting phenomenon, which is unique to Japan.

Judging from the facts above, we believe that there would be a trade-off between the sustainability of a company and its scalability, unless critical governmental regulations exist. Sustainability is an extension of a business to the time axis, while scalability can be considered as a spatial extension. There would be some governance rules between the two extensions.

As described in the previous sections, the Japanese Creative Service organizations can sustain their operations longer than the non-Japanese Creative Service organizations. One main reason for this is that the Japanese Creative Service organizations have stated the importance of the long-term trustworthy relationships with their stakeholders such as their customers, business partners, employees, and even the protection of society as their corporate missions. Sometimes, such long-term relationships imply the trust which was formed by the company for many generations. Therefore, by working with their trustworthy frequent users, their businesses stand by not being based on value in exchange, but they are mainly based on value in use.

It takes a longer period of time to establish the long-term trustworthy relationships between one another, but once it is established, it would be easy to collaborate together toward maintaining businesses. These sense of values would be the most important toward maintaining sustainability.

In addition to state the corporate mission of the long-term trustworthy relationship, Japanese Creative Service has a unique succession process. For example, Japanese cultural activities such as tea ceremonies and flower arrangements adopt an exclusive inheritance system called *Isshi-Soden*. That is, all the authorization rights and technology/service competences are transferred only to the designated successor. This process maintains the brand value of a Japanese Creative Service to sustain the operation.

As a next step, it is important to emphasize the scalability for Japanese Creative Services while maintaining their sustainability. To do so, human resource development is mandatory for increasing the number of people who understand the value of the Japanese Creative Services. In addition, we should make sure that we can differentiate which contexts should be kept with longevity and the others which should be accommodated accordingly with the new environment. From this differentiation, we can strive to enhance the scalability inside the value co-creation processes.

With this in mind, we should continue to raise the awareness of these value co-creation processes inside the global society, to avoid the diminishment of value, and to build a framework that is sustainable and has the opportunities of being developed. It is essentially important to continue to look into these values and see through their maneuvering capabilities, which would lead to a brighter future which utilizes the concepts of the Japanese Creative Services.

References

Chandler, J. D., & Vargo, S. (2011). Contextualization and value-in-context: How context frames exchange. *Marketing Theory, 11*(1), 35–49.

Chesbrough, H. (2011). *Open services innovation: Rethinking your business to – grow and compete in a new era*. San Francisco: Jossey-Bass.

Grönroos, C. (2000). Creating a relationship dialogue: Communication, interaction and value. *The Marketing Review, 1*(1), 5–14.

Hall, E. T. (1976). *Beyond culture*. Garden City: Anchor Books.

Hara, Y., & Yamauchi, Y., et al. (2012). How Japanese traditional “Omonpakari” services are delivered – a multidisciplinary approach. SRII2012.

Hofstede, G. (1984). Cultural dimensions in management and planning. *Asia Pacific Journal of Management, 1*(2), 81–99.

Kobayashi, K., Hara, Y., & Yamauchi, Y. (Ed.). (2014, October). *The era of Japanese creative services – A scientific approach to ‘Omotenashi’*, Nippon Hyoron Sha, 229 pages. (in Japanese).

Payne, A., Storbacka, K., & Flow, P. (2008). Managing the co-creation of value. *Journal of the Academy of Marketing Science, 36*, 83–96.
Prahalad, C. K., & Ramaswamy, V. (2000). Co-opting customer competence. *Harvard Business Review, 78*, 79–87.
Prahalad, C. K., & Ramaswamy. (2004). Co-creation experiences: The next practice in value creation. *Journal of Interactive Marketing, 18*(3), 5–14.
Vargo, S., & Lusch, R. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing, 68*, 1–17.
Vargo, S., & Lusch, R. (2006). Service- dominant logic of marketing: What it is, what it is not, what it might be. In R. Lusch & S. Vargo (Eds.), *The service- dominant logic of marketing: Dialog, debate, and directions* (pp. 43–56). Armonk: M. E. Sharpe.
Yamauchi, Y., & Hiramoto, T. (2013). *Presenting and negotiating selves: Initial service encounters at Sushi restaurants*. The 1st International Conference of Serviceology (ICServ).

Implementation Model for the Gamification of Business Processes: A Study from the Field of Material Handling

Markus Klevers, Michael Sailer, and Willibald A. Günthner

Abstract Gamification, as opposed to serious gaming, focuses on the integration of certain elements and mechanics from the field of gaming and game design into an existing (nongaming) environment. Typical game design models do not meet the requirements of implementing a gamification application in total because they focus on the development of a holistic game. An implementation model for the gamification of business processes should focus on the integration of game elements and mechanics into an existing work context instead. An implementation model was designed to fulfill these demands and will be presented in this paper. The so-called GameLog Model can be divided into three major phases: the *analysis and exploration* phase, the *design and realization* phase, and the *evaluation and reflection* phase. Within the *analysis and exploration* phase, the context that should be gamified is described on a granular level to find integration points for the game elements that do not change the process. In the *design and realization* phase, the gamification application is developed and implemented in the nongaming context. During the *evaluation and reflection* phase, the success of the application, as well as the acceptance of the employees, is measured. Results lead to a possible redesign. The model was evaluated by designing and testing a gamification application for the field of material handling. The gamification prototype was created for the process of manual order picking. Significant results could be achieved in fostering motivation and improving performance among workers in this process. Hence, the introduced model does work to successfully implement a gamification application into a business process. Gamification can also be seen as a useful approach to foster motivation and increase the performance of employees.

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1 Gamification

Gamification is an approach to foster motivation, engagement, learning, or problem-solving activities in nongaming, real-world contexts (Kapp 2012). The concept originally derives from marketing and has been applied in context areas to motivate employees, engage customers, or change specific behaviors (Werbach and Hunter 2012). The basic idea of gamification is to apply game design elements in the abovementioned nongaming contexts (Deterding et al. 2011). Exemplary game elements are points, badges, leaderboards, or levels (cf. Kapp 2012; Werbach and Hunter 2012). It is expected that these elements from games, which are normally meant to entertain players, can help to use the appeal of games for the immersion of people in working or learning experiences.

As gamification does not require the development of a holistic game, existing game design models cannot be used one-to-one. They focus on the creation of a complete game in an open context. So for the integration of gamification in business processes, an implementation model is needed that on the one hand helps do develop game mechanics and game dynamics, but on the other hand focuses on the analysis of the possibilities to include the specific game elements into existing business processes and environments.

In this paper an implementation model will be described that was designed and tested in the development of a gamification application for the material handling process of manual order picking. The following chapters will describe the implementation model (2), the usage of the model to design a gamification application (3), and the results and findings within this process (4).

2 Implementation Model for the Gamification of Business Processes (The GameLog Model)

To implement gamification into business processes, a procedure or implementation model is helpful. That model should not focus on the design of games, but on the enrichment of business processes with game mechanics and game elements. As gamification deals with existing (business) processes, it is necessary to take a closer look at these existing processes and business structures within the designing and implementation of a gamification application.

A model (the GameLog Model) was designed to implement gamification into business processes. It consists of three separate steps which should be passed one by one: *analysis and exploration*, *design and realization*, and *evaluation and reflection*. An overview of the implementation model is shown in Fig. 1. These major phases were created referring to existing design and implementation models like the waterfall model (Mall 2009) or the Deming Cycle (Deming 2000).

In the following, the GameLog Model will be described by means of the three comprising phases.

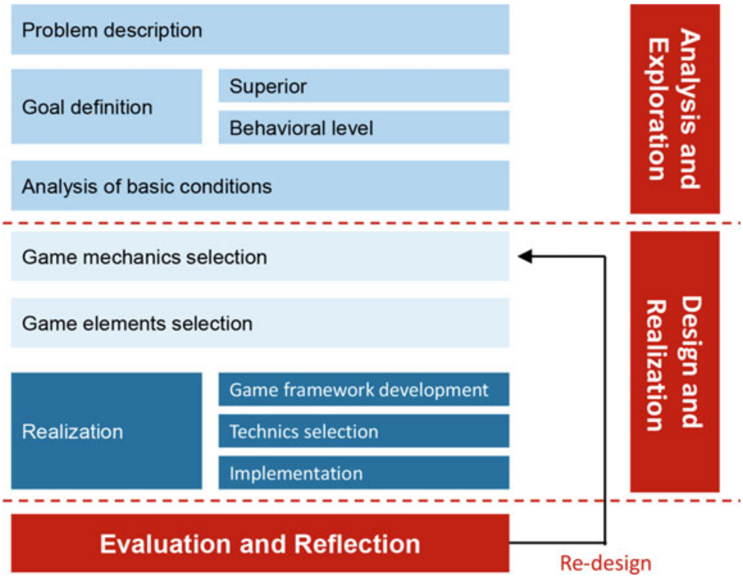

Fig. 1 GameLog Model: implementation model for the gamification of business processes

2.1 Analysis and Exploration

To start the development of a gamification application, it is necessary to understand the problem that should be solved or the situation that should be changed by using gamification. Within the *problem description* phase, a distinct description of the certain problem or starting situation is issued. Without a clear description, it is not guaranteed that the next model steps will lead to the claimed results.

Based on the *problem description*, the goals of gamification are defined in the *goal definition* phase. Two different aspects have to be taken into account: *superior goals* and *goals on the behavioral level*. *Superior goals* are directly related to the problem(s). It is the translation and rewriting of the addressed problem(s) into the demanded results. Those can be defined from the view of employers and employees. It is important to take the view of the employees (the employers) into account to guarantee the success of the gamification application. Existing key performance indicators can be used to define the superior goals and be used for performance measurement after the implementation. *Goals on the behavioral level* describe the specific behavioral change that should be achieved within the employees. It cannot be measured by direct quantitative indicators. Qualitative goals fall into this category. *Goals on the behavioral level* directly refer to the addressed employees.

One of the most important steps for the successful implementation of a gamification application into a business process is the *analysis of basic conditions*. The following question needs to be answered here: How can the gamification application be integrated into the existing work context without changing the process execution? The possibilities of integrating game elements into the work context are identified. Therefore, the process is documented on a very granular level. That means, all tasks the employee has to fulfill during the execution of his routine have to be documented. This helps to create a gamification application that can be integrated into the work process without changing it. Hence, the employee can choose for himself whether he wants to participate in the gamification or not. This supports the creation of intrinsic motivation, which in turn helps to reach the demanded goals (Cameron and Pierce 2006). Additionally, possibilities to integrate the gamification application into the technical operational system and the organizational structure of the company have to be identified.

2.2 Design and Realization

After having analyzed the work context and its process execution on a granular level, the gamification application itself is developed and implemented. This is undertaken in the *design and realization* phase.

The *game mechanics selection* is the first step to developing the application. The results of the *goal definition* are depicted in the game mechanics. There are different definitions to be found for game mechanics. Hunicke et al. (2004) describe the mechanic of a game as the "various actions, behaviors and control mechanisms afforded to the player within a game context" (Hunicke et al. 2004, p. 3). Another definition is given by Salen and Zimmerman (2004). They describe game mechanics as the "essential play activities players perform again and again and again" (Salen and Zimmerman 2004). To break it down for gamification, it is necessary to understand game mechanics within the context of gamification. Mechanics do not refer to explicit activities in that context, but to the mechanisms that trigger the defined goals and make the user change his behavior in that direction. Mechanics in that context could be collaboration, competition, character development, feedback, or concrete objectives.

Once game mechanics are defined, game elements are selected to trigger these mechanics. *Game element selection* defines the basis of the gameplay of the gamification application. Game elements trigger the chosen game mechanics. Thus, goals, game mechanics, and game elements build a direct causal link with each other, which can be found in Fig. 2. Game elements can be, for example, points, badges, high score lists, performance graphs, or avatars.

The next step in the *design and realization* phase is the *realization* itself. It starts with *game framework development*. The framework consists of the rules and the theme of the game. The rules consolidate the game elements into an overall concept. The dynamic of the application is created. The theme of the gamification application should be in the interest of the employees. Therefore, it is important to study the interests and demands of the designated users. *The technics selection* deals with the selection of suitable soft- and hardware to create the physical

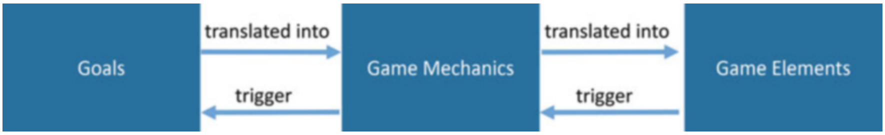

Fig. 2 Causal link between goals, game mechanics, and game elements

components of the gamification application. This includes the system architecture comprising all required interfaces to the existing operative system. Interfaces are needed if information has to be committed between the operative system and the gamification system to create game events. In most applications, this is the case because events in the gamification environment are triggered by specific actions in the business process. The last step is *implementation*. All theoretically acquired components are implemented, tested, and finalized. This step could result in a reconsideration of the *technics selection*.

2.3 Evaluation and Reflection

Most development projects in the field of gamification conclude with the delivering of a functioning application. Following the idea of continuous improvement (Imai 1968) and the Deming Cycle (Deming 2000), the GameLog Model contains a third phase after the successful implementation: the *evaluation and reflection* phase. This phase can and should result in a redesign loop to improve the application for a longer life cycle. The target of the *evaluation and reflection* phase is to continuously measure the achieved results and acceptance among the employees. Therefore, the once defined key performance indicators can be used. The acceptance of the employees cannot be measured by those indicators determined in *goal definition* but has to be analyzed with separate surveys among the users. The participant or dropout rate could be an indicator that points toward the acceptance of the gamification application. Even elaborately designed games have a set durability and have to be redesigned, updated, or enriched with new features to keep them alive.

3 Model Application in the Field of Material Handling

The GameLog Model was tested to create a gamification application for the field of material handling that is concerned with the internal handling of materials and supplies within specific production sites or intermediate storage facilities (Arnold 2006). Within material handling, the process of order picking was gamified. Order picking means fulfilling a customer's order, which includes receiving a list of items to be picked from storage and combining them into a shipment (cf. Coffey 1999).

Order picking is the typical core process that is fulfilled in trading companies like Amazon to create a box with the customer's order to deliver.

This chapter will explain how the process steps were undertaken and what result was achieved by means of the certain steps.

3.1 Problem Description

During the process of order picking, orders have to be fulfilled in shifts and under time constraints with as few errors as possible and can easily involve dozens of orders. Due to these challenges and context conditions in this monotonous work process, and taking into account that order picking is typically performed by low-paid unskilled workers, staff motivation and high turnover rates are recurrent problems for efficiency in material handling. Along with that, a loss of performance and increasing error rates among staff members are the result.

3.2 Goal Definition

From the employer's point of view, the superior goal is *increased performance* of the order pickers. This means a reduction of the error rate, an increase in the pick rate, and a *better and shorter learning and training process* for new staff members. From the order pickers' point of view, the superior goal is an *increase in work motivation* and *better preparation for the daily working routine*. Two goals determine each other, as higher work motivation can result in higher work performance. Existing key performance indicators that can be taken into account to measure the performance of the gamification application are the number of picks per worker per shift, the error rate, and the average time per order. All of these indicators are normally gathered within the operative system.

Goals on behavioral level refer to the employees, the order pickers. In the observed context, *faster and more precise work execution*, *promotion of the group orientation*, and *support within the employees* are goals from this perspective. As well, staff members *should be motivated to reveal problems* within their work execution and come up with solutions and improvement proposals.

3.3 Analysis of Basic Conditions

For the analysis of basic conditions, the examined work process was documented on a granular basis. In the specific process, an order is sent to the order picker onto a handheld scanner. After receiving the order, the order picker goes through the warehouse to pick out the items that are shown within the order list. After picking an item, the pick is confirmed by scanning a barcode on the shelf within the warehouse. All items are collected in a transport container, which is then delivered to a drop-off point. Afterward, the order picker requests a new order to repeat the specific tasks for the next order. All order pickers working together in one shift perform these tasks simultaneously in the same area of the warehouse. There are multiple staff members working together in the same process.

As for the concept, integration points have to be found in this process. To integrate the gamification application without changing the work, the order picker can only actively interact with the game in between two orders. Otherwise, the work process is interfered. During the fulfillment of an order, only passive interaction is possible. That means audiovisual feedback, for example, via displays that should be installed in the warehouse. The display of the handheld scanner itself can also be enriched with certain game elements.

Within the work process, there are some interfaces between the order picker and the operative system. The order picker actively requests a new order, scans a barcode after each pick, and confirms the completion of each order by delivering the transport container to the drop-off point. Thus, the chosen key performance indicators can be measured, and the existing interfaces can be used to create game events.

3.4 Game Mechanics Selection

To select game mechanics for the gamification application, the goals have to be translated into specific mechanics. The major goals in the examined context can be described as an increase in work performance and motivation as well as an improvement in the training of new staff members.

As for motivation, the self-determination theory by Deci and Ryan (1985) was chosen as the basic framework. It implies that human beings are motivated to work if they encounter feelings of being competent in dealing with a situation or task (competence), if they are free to make their own choices (autonomy), and if they are part of a community with relevant others (social relatedness) (Deci and Ryan 1985). Most of these needs are not fulfilled in the process of order picking as the work is heteronomous, simple, and monotonous. Also, all staff members work by themselves. Hence, game mechanics were chosen that could affect these basic needs.

To support the feeling of competence, the game mechanics of *feedback*, *result transparency*, *concrete objectives*, and *competition* were chosen. As for *competition*, it is important not to generate an environment in which employees try to manipulate each other to get better results. Therefore, a *team competition* in which all members of one shift function as a team was chosen as the mechanic of choice.

To fulfill the need of autonomy, the staff member must be given a chance for *individualization*. This strongly contrasts with the actual work task, as all order pickers work the same routine over and over again and are easily interchangeable.

The game mechanics, *profile and character development* and *freedom of choice*, were chosen to encounter that.

Social relatedness should be triggered through the game mechanic, *collaboration*. Goals should be set that can only be solved if the team members work together.

Besides the goal of fostering motivation, performance should be improved by the gamification application. The chosen game mechanics work toward that goal and can achieve it by fostering the staff's motivation. The training process is not improved by a game mechanic, but by a direct game element. This will be explained in the next chapter.

3.5 Game Element Selection

Game elements were chosen to trigger the mentioned game mechanics.

Points can be earned by the order picker for good results in the process. *Points* give feedback about the rendered performance. Therefore, it is important that the user understands how points are measured. Besides feedback, *points* target the mechanics competition and result transparency.

Badges are given to the staff member for outstanding performance and the fulfillment of certain goals. They trigger the game mechanics' concrete objectives, competition, and result transparency. *Badges* can also foster collaboration as order pickers with the same badges could feel a connection between each other.

To support the game mechanics competition, it was chosen to use a *high score list*. As mentioned before, however, the *high score list* does not display the ranked results of each individual order picker, but the team's outcome. Hence, the game element can trigger collaboration as well.

The game element, *performance graph*, was chosen to target the mechanics, concrete objectives and result transparency. The graph displays the result of the order picker in the categories of executed picks, required time per order, and errors per order. Thus, the staff member gets feedback about his performance and his improvement in the particular categories. The *performance graph* is only visible to the user himself so that it cannot result in pressure from other team members.

The user of the gamification application will have the choice between different *avatars* that represent him in the gamification environment. This should trigger the game mechanics of profile and character development and freedom of choice. This is because the user can develop his *avatar* in different directions. This in turn can lead to a certain level of individualization.

Another element that was chosen is a *narrative*. The other elements are combined into a story that has been told during the use of the gamification application. As there are decisions to make within that story, it supports the game mechanic, freedom of choice.

The last element to be implemented within the gamification application is a *tutorial*. The *tutorial* helps to learn the game dynamics and rules within the gamification application. That directly supports the training of new staff members and helps the order pickers become better prepared on the job.

3.6 Game Framework Development

The game framework describes the theme the application is located in and the gameplay rules.

The theme of the application is a futuristic virtual order picking league. It was decided to not take the theme too far away from the work context, as it should interest the whole employees. Every other theme allows for the possibility that certain staff members feel excluded because they do not feel connected to the theme at all.

The rules combine the game elements and create the game dynamic for the gamification application. At the beginning, staff members create their own character by choosing from six different avatars that differ in their attributes. In total, there are three attributes, namely, speed, strength, and accuracy. These are linked to the three major key performance indicators: picking time, number of picks, and picking errors. The attributes work as multipliers to gain points. The faster the employees finish their order, the more points they get through the attribute speed; the more picks they make, the more points they get through the attribute strength; the less errors the employees make, the more points they can earn through the attribute accuracy.

After creating the character, staff members get access to their own game profiles. Here they can find an overview of their character's attributes, team high scores, leaderboards, statistics and summaries about their performance in the gamification application (performance graphs), information about running game rounds, and a list of all badges. Badges can be earned by reaching certain goals. For example, a badge is given for a series of ten orders without any error. Badges are rewarded with attribute points. These can be used to upgrade the character's three attributes. From the performance graphs in the profile, the users can see how many points they have already got in each of the three sections and develop their avatars in a certain direction.

From their profile, order pickers can join a team to fight for the win of the order picker league. When joining a team for the first time, the game round starts with a tutorial. This takes place directly in the warehouse. The tutorial consists of an interactive movie in which the order picker is introduced to the background story of the order picking league and to the rules of the gamification application. During the tutorial, the users learn how to handle the handheld device and have to fulfill exemplary orders. The rules of the game contain the order picking process steps mentioned before. In summary, the employees are trained in the gamification application and in their daily work routine at the same time.

Afterward, the game round starts at a certain time. Staff members fulfill their orders and get feedback about earned badges or if the team climbs in the tea, high score list. All points of the team members are summarized to represent the team points which are shown in this high score list. After delivering a complete order, the order picker gets feedback about open attribute points. From this information they can chose to upgrade their character before requesting the next order.

When a game round is finished, a short debriefing film is shown. The content of the film varies according to the team's performance and result. Also, the best participants with the most points and most badges are honored. This is the only time where personal statistics will be displayed.

3.7 Technics Selection

This paragraph is cut short, as the technics selection is not relevant for the purpose of this paper. During this step, a number of different frameworks, soft- and hardware components, protocols, and programming languages were chosen to create the described gamification application.

3.8 Implementation

The gamification application was integrated into the order picking process. Computer stations were established on which the employees could log in to their profiles, upgrade their characters, and get information about their performance and the running game round. Order pickers could join a team from these computers as well.

Inside the warehouse, big screens were installed. The so-called *ingame screens* show the current team high score list, the points of the team playing, and the remaining game round's time. Every time an order picker wins a badge, an animation is played.

At the drop-off point, a *feedback screen* is mounted. This screen contains information about the delivered order. The number of points gathered per picks, time, and errors is displayed. Performance graphs also show the progress over the last five orders. The recently earned badges, total gained points, and open attribute points are shown on the *feedback screen* too.

The application running on the handheld scanners was enriched with the earned points, a picture of the avatar, and the time elapsed since the recent order was started.

3.9 Evaluation and Reflection

The evaluation of the gamification environment was performed through an analysis of two of the mentioned key performance indicators and a survey within the users.

Therefore, a study with 103 participants was conducted. To examine the training process of new staff members, test persons that had not worked in order picking before were recruited. Fifty-one participants were trained and worked within the original order picking process (reference group), while 52 participants were put in the gamified work process (experimental group). The training lasted 10 min. Afterward, the test persons worked within the order picking process for 20 min.

As for the performance, a significant difference between both groups could be achieved. In 20 min, the test persons in the normal order picking process performed 46.82 picks on average, while test persons with gamification executed 62.43 picks. The number of errors could also be significantly reduced through the use of gamification. While the reference group permitted 14.76 errors on average, the gamification group only permitted 9.63.

Motivation was surveyed using a questionnaire with open questions and statements that should be rated on Likert scales from 1 to 7 (Brace 2008). As a result, in all of the three mentioned motivational needs, a significant improvement was achieved by the use of gamification. On average, between the test persons and the corresponding questions, the need for competence could be raised from 4.11 to 4.90, the need for autonomy from 3.64 to 4.04, and the need for social relatedness from 1.93 to 3.33. Also, intrinsic motivation was surveyed directly. On average, the reference group rated their intrinsic motivation 3.71, as the experimental group rated it 5.00. This is a significant difference as well.

The training process was surveyed by the questionnaire too. The preparation for the work task was rated by the reference group with 4.27 and by the experimental group with 4.90. This is a significant improvement. No improvement could be achieved in the training quality via gamification. An explanation for that could be that the tutorial was not sensed as training by the test persons.

The acceptance among the employees was surveyed with open questions. Results are that the gamification application was a welcomed alternation in the daily work routine. Test persons liked to play the game, but stated that the complexity of the gamification application could lead to boredom after a while. So a redesign should take place to improve and change the game procedure and dynamics after a while.

4 Conclusion

In this paper an implementation model for the gamification of business processes was presented. It contains three major phases: analysis and exploration, design and realization, and evaluation and reflection. The model does not focus on the creation of a holistic game, but on the integration of certain game elements and mechanics into a running business process without changing its execution.

The model was used to create a gamification application in the field of material handling. This application was evaluated. Findings from this evaluation show that, on the one hand, the implementation model does work to successfully gamify a business process; on the other hand, the study displays that gamification is a useful approach to foster motivation and performance among employees in business processes.

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References

Arnold, D. (Ed.). (2006). *Intralogistik. Potentiale, Perspektiven, Prognosen [Material handling. Potentials, perspectives, prognoses]*. Berlin: Springer.

Brace, I. (2008). *Questionnaire design: How to plan, structure and write survey material for effective market research*. London: Kogan Page Limited.

Cameron, J., & Pierce, D. W. (2006). *Rewards and intrinsic motivation: Resolving the controversy*. Westport: Greenwood Publishing.

Coffey, D. (1999). Zero in on picking. *Logistics & Transport Focus, 1*(4), 22–25.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum Press.

Deming, W. E. (2000). *Out of the crisis*. Cambridge: MIT Press.

Deterding, S., Khaled, R., Nacke, L., Dixon, D. (2011). *Gamification: Toward a definition*. Paper presented at the CHI 2011, Vancouver.

Hunicke, R., LeBlanc, M., Zubek, R. (2004). *MDA: A formal approach to game design and game research*. Paper presented at the game developers conference, San Jose.

Imai, M. (1986). *Kaizen (Ky'zen): The key to Japan's competitive success*. New York: Random House Business Division.

Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. San Francisco: Pfeiffer.

Mall, R. (2009). *Fundamentals of software engineering*. New Delhi: PHI Learning.

Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge: MIT Press.

Werbach, K., & Hunter, D. (2012). *For the win: How game thinking can revolutionize your business*. Philadelphia: Wharton Digital Press.

ColPMan: A Serious Game for Practicing Collaborative Production Management

Hajime Mizuyama, Tomomi Nonaka, Yuko Yoshikawa, and Kentaro Miki

Abstract This paper describes the development of a serious game, named ColPMan, which enables practitioners, undergraduate students, and graduate students in the industrial engineering and management fields to experientially learn dynamic decision-making skills for collaborative production management in a large-scale make-to-order company. In ColPMan, a team of players collaboratively operates the virtual in-house supply chain of a manufacturer, in order to maximize profit (i.e., game score). The supply chain is composed of a headquarters that accepts orders from customers, an upstream factory producing materials, and three downstream factories processing materials into products. Each player is assigned to one of the sites and makes production and delivery plans for that site. Since the operations of different sites within the chain are related to one another, the players need to learn to develop a shared strategy and act in a coordinated way with regard to various environmental disturbances in order to obtain a high score. The developed game has been tested in an undergraduate classroom exercise, with a positive response from students.

1 Introduction

Production management is an important function for a manufacturing company. It involves forecasting future demands, controlling inventories, and planning and scheduling production and delivery operations. Various university lectures and seminars on production management are available to practitioners, making it possible to study mathematical techniques for demand forecasting, production planning, inventory control, scheduling, and so on. These techniques help to improve the quality of various decisions made by production managers. However, mathematical techniques alone do not make it possible to effectively engage in *production management* in a practical environment, and especially in a large-scale

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make-to-order (MTO) company. Such a company consists of several factories and warehouses, and the operational plans and schedules of those sites are related to one another. Furthermore, the production and delivery operations of those sites are affected by various environmental disturbances, such as changed orders, lead-time variations, defective items, shortages, and machine failures. Hence, even though the quality of elemental decisions can be high, in a static sense, that of the resultant *production management* as a whole may be quite low, unless decisions are updated in a timely manner and combined appropriately in a dynamic environment. However, such dynamic decision-making skills are not easy to develop, and training cannot take place through lectures alone.

As an alternative or supplemental training approach for developing the decision-making skills required in a dynamic environment, experiential learning can be applied. Serious games are a suitable means of doing so. Serious games can also be used to analyze or evaluate these skills. For example, Mohan et al. (2014) have developed and successfully used a serious game for analyzing physicians' triage decision-making skills. Graafland et al. (2014) have shown that serious games can be used as valid evaluation and training methods regarding clinical decision-making skills in surgery. Dunbar et al. (2014) have developed a serious game for mitigating the cognitive biases of individuals making decisions under conditions of uncertainty and have confirmed its effectiveness. All of these serious games focus on specific decisions made by single individuals. However, when organizational decision-making skills are a focus, serious games can be played collaboratively by teams of players. For example, Meijer et al. (2012) and van den Hoogen and Meijer (2015) have engaged in participatory simulation by using a serious game to analyze how the Dutch railway system is operated through various stakeholders' organizational decision-making processes.

Serious games have also been successfully utilized in the fields of manufacturing and supply chains. For instance, the tools and concepts of lean manufacturing, such as pull production and continuous improvement, are often taught to practitioners experientially by using serious games. Ncube (2010) has introduced an example of such practices, while Badurdeen et al. (2010) have carried out a survey of serious games for this purpose. However, most of the games in this category only consider a single production system or a factory and hence are not suitable for training players how to collaboratively operate a supply chain composed of multiple sites. One of the most well-known games that models supply chain operation is the beer distribution game (Sterman 1989). The game is played by a team of players, each of whom is assigned to a retailer, wholesaler, distributer, or factory site. The players make decisions regarding the inventory management of their sites. The performance of the supply chain, under a specified customer demand pattern, is then determined based on a combination of the players' decisions. Since the original beer distribution game only considers a supply chain with a linear topology, Hofstage et al. (2003) have extended it to cover more general supply chain topologies and to incorporate more strategic decisions, such as who to do business with. However, these supply chain games only cover storage and delivery operations, and production planning and scheduling are outside of their scope.

Furthermore, the players are not allowed to communicate when playing the games, and so the performance of the supply chain can only be studied under conditions without effective collaboration.

With this in mind, the objective of this study is to develop an original serious game called ColPMan, the abbreviation of the term *Collaborative Production Management*, which is suitable for training players in the dynamic organizational decision-making skills required to collaboratively operate the in-house supply chain of a large-scale MTO company. This study also tests how the developed ColPMan works.

2 Serious Game Design

2.1 Supply Chain Topology

Operational planning and control in the in-house supply chain of a large-scale MTO company can be captured through a dynamic combinatorial optimization problem that determines the production and delivery schedules in the chain, in a mathematical sense. Since such a problem will be large scale, it can be divided into several subproblems, which are handled by multiple decision-makers located at different sites composing the chain. Furthermore, since the problem will be dynamic in nature, each subproblem will be repeatedly solved, reflecting the changing environment. It should be also noted that information on the changing environment will be dispersed among the sites, with no decision-maker seeing the entire picture of the environment. However, since the subproblems are related to one another, a seemingly improved solution to a subproblem may degrade the overall performance of the chain. Thus, it is important for decision-makers to not only appropriately solve respective subproblems but also to effectively coordinate and communicate with one another. ColPMan, which is the serious game developed for this study, aims to enable players to experience dynamic decision-making as a team and learn the necessary skills involved.

First, the topology of the supply chain of ColPMan must be modeled. Unlike a small- or medium-sized manufacturer with only a single factory, a large-scale MTO manufacturer usually operates multiple factories. Those factories handle different steps of the production process for the products offered by the company. It is also a common practice for some of the factories to be in charge of the same part of a process while operating in different geographical areas. In addition to those factories, the headquarters that accepts orders from customers is an important component of the supply chain. Thus, the possible relationships among the sites composing the supply chain can be categorized into the following:

- *Serial function sharing*
- *Parallel function sharing*
- *Hierarchical function sharing*

Serial function sharing describes the relationship between factories that handle consecutive steps of a production process. Since it is difficult to carry out all of the steps in a lengthy production process in a strictly coordinated manner, the process is usually divided into two parts with a storage step, which is called the decoupling point. The downstream part is operated in an MTO fashion, while the upstream part is operated in a make-to-stock (MTS) fashion. This means that, in general, even an MTO manufacturer will not only have MTO factories but also MTS factories, and those factories together will comprise its in-house supply chain. Since the downstream part is operated in an MTO fashion, it is run according to a single coordinated production plan and schedule. Thus, that part can be modeled as a single unit. On the other hand, since the upstream part is operated in an MTS fashion, it can be further divided into several units operated with separate production plans and schedules and connected sequentially with storage steps. However, even when the upstream part is broken up by several storage points, there can only be a small number of such points within the in-house supply chain in actual practice. Furthermore, the relationships between some sequentially connected storage points can be effectively studied with the beer distribution game. Thus, the upstream part is also modeled as a single unit in ColPMan.

Parallel function sharing describes the relationship between factories in charge of the same part of the production process. Factories' *sharing functions in parallel* are interchangeable in a sense and add robustness to a supply chain. For instance, if a major machine failure occurs in a factory, the jobs that were planned for processing with the failed machine can instead be processed on a similar machine in another factory that *shares functions in parallel* with the factory with the failed machine. It should be noted that when there are only two factories *sharing functions in parallel*, no choice needs to be made, and the second factory will be relied on. Furthermore, in the supply chain of ColPMan, robustness is more important in the downstream unit, because the unit is operated in an MTO fashion. Thus, in the supply chain of ColPMan, three factories are assumed to *share functions in parallel* in the downstream unit.

Hierarchical function sharing describes the relationship between the headquarters accepting orders from customers and the downstream factories processing products corresponding to the orders. The decision-maker in the headquarters assigns accepted orders to the downstream factories, and the decision-maker in each downstream factory determines the more detailed production schedule for the assigned orders.

Accordingly, the overall topology of the supply chain for ColPMan is as shown in Fig. 1.

2.2 Material and Information Flow

As shown in Fig. 1, the upstream factory produces materials, and the inventory point for the materials is located both at the exit of the upstream factory and at the

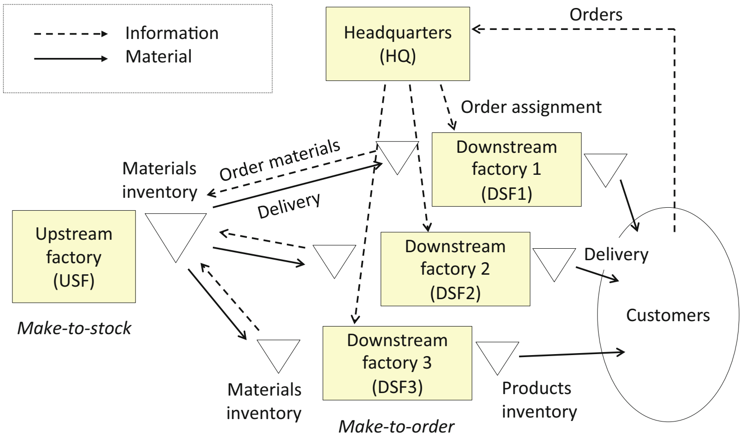

Fig. 1 Supply chain of ColPMan

entrance of each downstream factory. The materials are then processed into products at each downstream factory, and the products are stored in the inventory at the exit of the downstream factory until they are delivered to the customers who ordered them. To make the mission neither too simple nor too complicated, materials are classified into five types, and five sizes of products are produced from the materials of each type. This means that there are 25 different products.

Both the upstream and the downstream factories are modeled as a single machine with sequence-dependent setup times. This simple model makes the scheduling problems for each factory manageable for the game players. Materials are delivered from the upstream factory to every downstream factory once per specified time period, which is referred to as a term. Products are also normally delivered to customers once per term, but additional emergent deliveries are triggered, with additional costs, if a due date has passed.

Customers can place orders at any time. Each order specifies the type, size, volume, and due date of the products involved. At the beginning of each term, the headquarters determines whether the company will accept each order. Once an order has been accepted, the products specified in the order must be produced and delivered to the customer, unless the customer cancels the order. At the same time, the headquarters assigns orders that have not yet been assigned to future terms (this, next, and the one after the next) and to downstream factories 1, 2, and 3. The assignments for future terms can then be modified at the beginning of the next term.

Next, each downstream factory creates its production schedule for the term. Setup is required only for sizes, and different types of materials can be processed in the downstream factory without setup. Setup is also longer and more expensive when sizes are changed in an increasing order. During a term, the factory produces products individually according to schedule, as long as the material required is in stock. If the material is out of stock, the production of the corresponding product is skipped. Thus, it is important for the factory to properly control its material

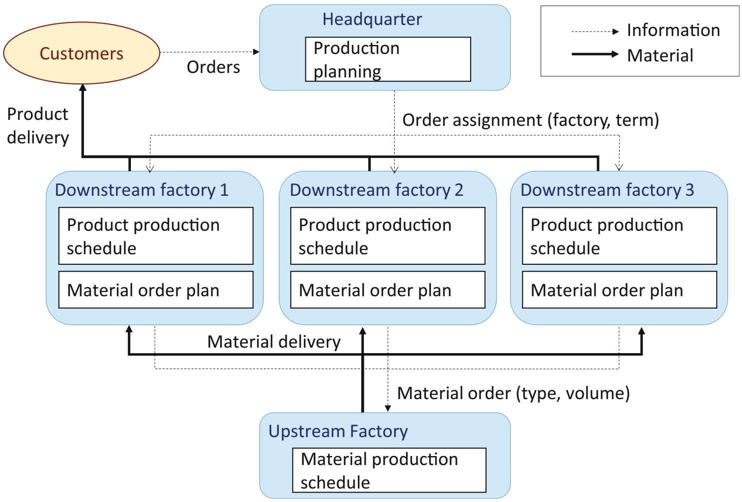

Fig. 2 Material and information flow in ColPMan

inventory. The downstream factory can place a material order at the beginning of each term.

Next, the upstream factory ships materials to the downstream factories according to the orders received from them. When sufficient materials are not available in its materials inventory, the number of materials shipped to a certain downstream factory is reduced. The factory also makes a production schedule for the term. Materials are produced in lots of a specified lot size. Setup is required between types, but unnecessary when materials of the same type are consecutively produced.

The flow described thus far is summarized in Fig. 2.

2.3 *Environmental Disturbances*

In order to make it possible for the players to learn how to effectively communicate and coordinate in a dynamic environment, various uncertainties are incorporated into the game. They include:

- *Orders and their arrival times*
- *Product production lead-times*
- *Defective items and machine failures in downstream factories*
- *Material delivery lead-times*
- *Material production lead-times*
- *Defective items and machine failures in the upstream factory*

These uncertainties work as surprising events. Van der Spek et al. (2013) argue that surprising events facilitate deep learning for serious game players.

2.4 Game Score

The game score corresponds to the profits obtained from running the in-house supply chain, which is calculated by subtracting various costs from revenue. The revenue is proportional to the number of products that are delivered to customers, whereas the costs considered include:

- *Materials inventory costs at both upstream and downstream factories*
- *Setup costs in both upstream and downstream factories*
- *Material delivery costs*
- *Product inventory costs*
- *Product delivery costs*
- *Late delivery penalty costs*

2.5 Game Flow

The game flow of ColPMan is shown in Fig. 3. When human players input their decisions, the progress of supply chain operation, according to decisions made under uncertainties, is calculated through a computer simulation. This cycle is repeated for a pre-specified number of terms.

2.6 Serious Game Implementation

The computer simulation of ColPMan and its graphical interfaces involving human players are implemented with *processing*, a *Java*-based programming language that is suitable for creating interactive graphics. A screen is provided for each site, and basic information on the progress that is directly observable from the site is visually displayed on that screen. More detailed progress information is given in the form of CSV files. The simulator also incorporates the decisions made by players with the same file types. Some example screens and codes are shown in Fig. 4.

3 Application Case

3.1 Experimental Setup

In order to test how the developed serious game works, ColPMan was actually played in a classroom. The participants were junior students in a course within the department of industrial and systems engineering at Aoyama Gakuin University in

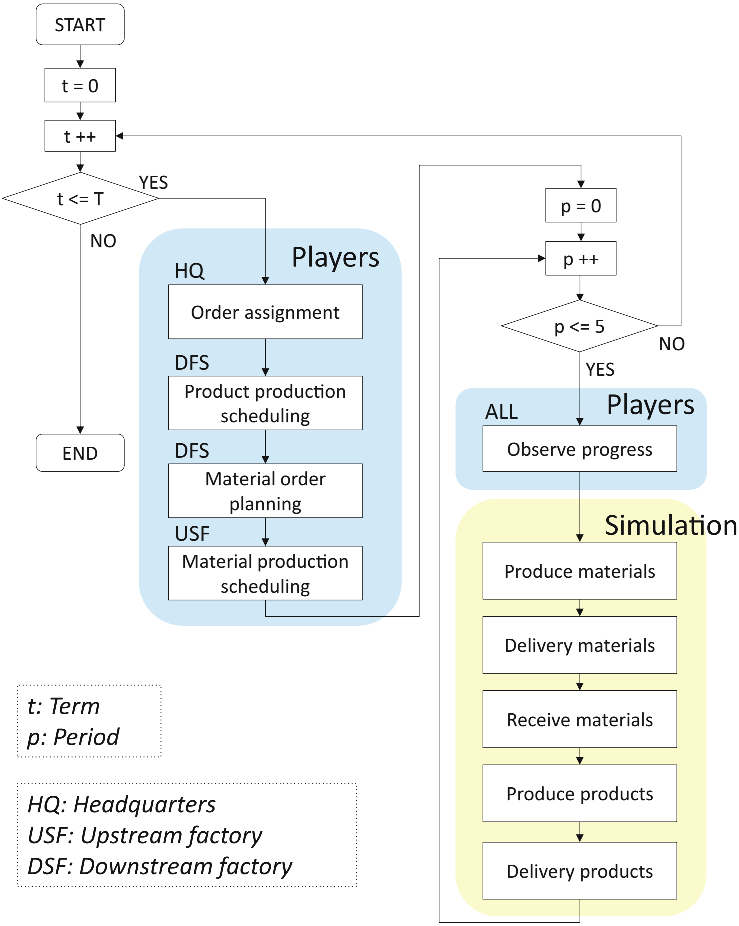

Fig. 3 Game flow of ColPMan

Japan. The course runs every Thursday and is composed of two 90-min time slots with 15-min breaks in between. Although the whole course lasts 15 weeks, only 5 weeks were instructed by the authors of this paper. The class schedule for the 5 weeks is shown in Table 1.

The objective of the course is twofold. The first goal is to understand how optimization techniques work in practical situations, while the second is to brush up on programming skills by implementing software related to optimization techniques. Thus, 2 weeks were devoted to programming exercises, and only three time slots were used for playing ColPMan. There were 107 students in total, who were randomly grouped into 12 teams, each composed of 8 or 9 students. One team member was assigned to the role of facilitator and was responsible for operating the simulation software. The others were assigned to one of the five sites. This means that some sites were controlled by a sub-team of two players. The role assignments

Fig. 4 Example screens and codes for ColPMan simulator

Table 1 Class schedule

	First time slot	Second time slot
First week	Introduction to ColPMan	Game play #1
Second week	Lecture on production management techniques	Game play #2
Third week	Introduction to programming exercise	Programming #1
Fourth week	Programming #2	Programming #3
Fifth week	Game play #3	Presentation

were determined by the students themselves. After each game play session, all the students were requested to hand in a report describing the key approaches for getting high scores in ColPMan.

3.2 Learning Effects

All of the reports submitted by the students were read through, and individual items describing a key point were carefully considered. Then, the obtained items were classified according to different principles. They were also categorized as headquarters (HQ)-related, upstream factory (USF)-related, and downstream factory (DSF)-related principles. This resulted in 9 overall principles, 7 HQ-related principles, 8 USF-related principles, and 17 DSF-related principles.

Figure 5 shows how many principles were actually mentioned in the students' reports, on average. For example, the upper left figure indicates that the upstream players mentioned roughly 0.6, 1.2, and 2.0 overall principles in their first, second,

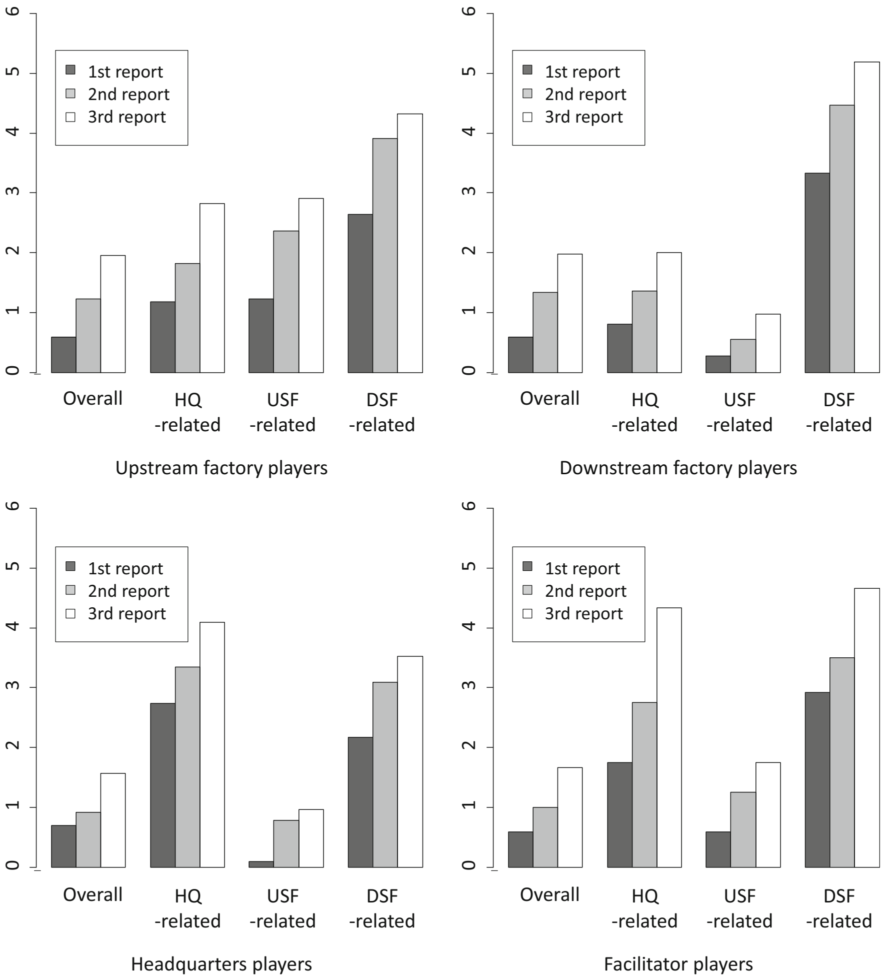

Fig. 5 Number of principles learned

and third reports on average, respectively. It can be immediately noticed that, for all of the cases, the number of principles clearly increases as students repeatedly play ColPMan. This provides indirect evidence that ColPMan helped the student players to become aware of those principles.

It is also obvious that the shapes of the bar graphs are different for different player types. A deeper look into these differences reveals several interesting tendencies, such as:

- The players assigned to a site mention a significantly higher number of principles related to the site than other players.

- Although the bar graphs of headquarters players and facilitators are similar, the number of USF-related principles is smaller for headquarters players than for facilitator players.

It can thus be suggested that the players' experiences, and hence the principles that they learn from them, depend on the roles that they are assigned. This is something that is difficult to learn from lectures alone. Furthermore, it may be helpful to have students experience different roles.

3.3 Subjective Evaluation

At the end of the fifth week of class, students were asked to answer the following questions.

- Q1: Did you enjoy playing ColPMan?
- Q2: Did your tactics change as you repeatedly played ColPMan?
- Q3: Was it possible to apply a strategy that you prepared beforehand?
- Q4: Was your motivation increased by game scores?
- Q5: If you had the chance, would you want to play ColPMan again?
- Q6: Was it difficult for you to play ColPMan?
- Q7: Is the ColPMan software easy to operate?
- Q8: Did ColPMan facilitate communication among your team members?
- Q9: Did ColPMan deepen your understanding of production management?
- Q10: Which do you think is more helpful for deepening your understanding: lectures or games like ColPMan?
- Q11: Would you want to use a simulation game like ColPMan for other purposes?
- Q12: Open question about possible improvements.

Table 2 shows the distribution of the answers collected from the students. In general, the students enjoyed playing ColPMan based on trial and error. They preferred ColPMan or similar games in other fields than lectures and would like to play it again if the chance is given. Furthermore, they acknowledged that ColPMan is effective for learning and encouraging communication. It should also be noted that many students, and especially facilitator players and headquarters players, felt that it was difficult to operate the ColPMan software, as well as to play the game itself. Thus, further simplification of the game structure, so as to level the workload of different roles, is necessary, and the software needs to be refined so that it can be easily operated. Most of the answers to Q12 are also related to these points.

Table 2 Questionnaire results

	Yes (lecture)	Slightly yes	Neutral	Slightly no	No (game)
Q1	47	42	11	2	0
Q2	45	48	8	1	0
Q3	32	57	5	6	2
Q4	55	33	10	4	0
Q5	36	40	16	7	3
Q6	22	55	21	4	1
Q7	15	34	13	33	7
Q8	72	26	2	1	1
Q9	35	58	6	2	1
Q10	7	10	10	27	48
Q11	54	37	9	1	1

4 Conclusions

As a medium for the experiential learning of dynamic decision-making skills for collaborative production management in a large-scale make-to-order company, this study involved the development of a serious game called ColPMan. The developed game was actually tested as an undergraduate classroom exercise. The learning effects provided by ColPMan game were indirectly observed, and the game was met with a positive response from students. For some players, and especially facilitator players and headquarters players, the game was too difficult to enjoy. Thus, future directions include further simplification of the game structure so as to level the workload of different roles, and software refinement for easier operation.

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References

Badurdeen, F., Marksberry, P., Hall, A., & Gregory, B. (2010). Teaching lean manufacturing with simulations and games: A survey and future directions. *Simulation & Gaming, 41*, 465–486.

Dunbar, N. E., Miller, C. H., Adame, B. J., Elizondo, J., Wilson, S. N., Lane, B. L., Kauffman, A. A., Bessarabova, E., Jensen, M. L., Straub, S. K., Lee, Y.-H., Burgoon, J. K., Valacich, J. J., Jenkins, J., & Zhang, J. (2014). Implicit and explicit training in the mitigation of cognitive bias through the use of a serious game. *Computers in Human Behavior, 37*, 307–318.

Graafland, M., Vollebergh, M. F., Lagarde, S. M., van Haperen, M., Bemelman, W. A., & Schijven, M. P. (2014). A serious game can be a valid method to train clinical decision-making in surgery. *World Journal of Surgery, 38*, 3056–3062.

Hofstede, G. J., Kramer, M., Meijer, S., & Wijdemans, J. (2003). A chain game for distributed trading and negotiation. *Production Planning & Control, 14*, 111–121.

Meijer, S. A., Mayer, I. S., van Luipen, J., & Weitenberg, N. (2012). Gaming rail cargo management: Exploring and validating alternative modes of organization. *Simulation & Gaming, 43*, 85–101.

Mohan, D., Angus, D. C., Ricketts, D., Farris, C., Fischhoff, B., Rosengart, M. R., Yealy, D. M., & Barnato, A. E. (2014). Assessing the validity of using serious game technology to analyze physician decision making. *PLoS One, 9*, 1–8.

Ncube, L. B. (2010). A simulation of lean manufacturing: The lean lemonade tycoon 2. *Simulation & Gaming, 41*, 568–586.

Sterman, J. D. (1989). Modeling managerial behavior: Misperceptions of feedback in a dynamic decision making experiment. *Management Science, 35*, 321–339.

van den Hoogen, J., & Meijer, S. (2015). Gaming and simulation for railway innovation: A case study of the dutch railway system. *Simulation & Gaming, 46*, 489–511.

van der Spek, E. D., van Oostendorp, H., & Meyer, J.-J. C. (2013). Introducing surprising events can stimulate deep learning in a serious game. *British Journal of Educational Technology, 44*, 156–169.

Massively Multiplayer Online Games as Information System: Implications for Organizational Learning

J. Tuomas Harviainen and Mikko Vesa

Abstract In this chapter, we discuss the implications of the information systems structures of massively multiplayer online role-playing games to organizational learning that takes place within them or connected to them. The games consist of three interdependent information systems: an information retrieval system accessed by using game content as its keywords, a social system formed by the players, and an expanded system that extends outside of play proper, in the form of experience records like game blogs and videos. By developing their procedural literacies, players learn to analyze the systems and to compare their content and logics to the real world. In-game groups in turn use strategic practices to spread such learning organization-wide, in order to foster efficiency and better content access. By cleverly using briefing, debriefing, and strategizing procedures, real-world organizations too can then learn from these processes, as they free their members from individual learning traps and extend the lessons gained from voluntary gaming into absorptive and adaptive real-world practices.

Keywords Information seeking • Information systems • MMORPGs • Organizational learning

1 Introduction

In this chapter, we examine the way massively multiplayer online role-playing games (MMORPGs) and their siblings function as information systems. It continues on the line of research earlier explored by, e.g., Harviainen and Savolainen (2014) and Harviainen and Hamari (2015), but emphasizes the implications that

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understanding information processes at play has for simulation/games. MMORPGs are online role-playing games that have active player bases between tens of thousands and several millions. Players interact with the worlds, their virtual denizens (e.g., monsters and computer-controlled characters), the environment, and each other through avatars, virtual representations of fictional personas. The avatars develop as play progresses, in both skill and wealth, including the acquisition of powerful items. In many games, players can also pay real-world money to get, e.g., better equipment or access to more content (Lehdonvirta and Castronova 2014). MMORPGs are persistent, meaning that they stay active and evolve even when some or all of their players are not logged on, and are virtual worlds, i.e., "expansive, world-like, large-group environments made by humans, for humans, and which are maintained, recorded, and rendered by computers" (Castronova 2005, p. 111). In order to access some of the content in the games, players need to form or join voluntary groups (called, e.g., "guilds" in World of Warcraft or "corporations" in the space game EVE Online).

In simulation/gaming terms, we can, following Crookall et al. (1986) and Thavikulwat (2004), consider MMORPGs to be extremely large environments of the "computer-controlled" type, meaning that they have both high participant-participant interaction and high level of computer control. As will be explained below, on another (social group play) level, they also exhibit traits of computer-assisted simulations: actions in guilds and corporations may be negotiated through player interaction rather than coded rules, and new social rule systems can be built within the game's framework, sometimes even subverting the purpose of the original game (Myers 2010). In this, they exemplify the way in which background material and task division can turn an otherwise computer-controlled game into a computer-assisted one, as suggested by Crookall et al. (1986). We believe this to be a result of how they function as information systems. Likewise, MMORPGs, being persistent virtual worlds, normally utilize synchronous, clock-driven time but may in some cases also have asynchronous, activity-based time (see Thavikulwat 2004): for example, players who have not defeated a particular main enemy in World of Warcraft may exist out of sync with those who have, until they complete that particular task.

As shown by, e.g., Whitton (2009, 2014), players appear to learn much from informal, voluntary play in MMORPGs and other recreational games: skills, knowledges, practices, and new perspectives. Multiplayer games are efficient tools for constructivist learning, as they help develop interpretative and reflective skills through social interaction, narrative structures, their potential authenticity of experiences, and the fact that they guide the players to engage with the environment and the processes on a personal, self-guided level (Lainema 2009; Tsuchiya 2014). This also extends to organizational learning, when player groups who want to face very powerful monsters ("bosses") or fight off rival organizations (e.g., other corporations in EVE Online) create strategic practices, which both draw upon but also potentially influence similar practices applied in real-world work environments (Vesa 2013; Warmelink 2014). In essence, these games are massive, undirected manifestations of what Klabbers (2000, p. 400) calls "Mode III" learning environments, "environments in which the learners are given the opportunity to interactively build their own system of resources and rules[, and which provide] conditions for the interactive self-reproduction of social systems." In MMORPGs, players have to organize in order to have good access to playable content, and they have to organize themselves efficiently, to take full advantage of that content. Thus, they learn – and they form learning organizations.

Two apparent constraints to this, however, exist. Firstly, games are, as learning environments, strongly affected by their architecture (Burns et al. 1990). They are always abstractions to some extent, and decisions regarding their content and affordances affect the way they are experienced (leigh and Tipton 2014). Key factors include freedom of action, freedom to go against designer intent in a productive manner ("functional bad play"; Myers 2010), and especially challenge levels (e.g., Carlson and Misshauk 1972). Like in business simulations (e.g., Titton 2014), in MMORPGs too, players prefer increased content and complexity as their skill grows. For learning, that content however has to be both focused and iterative. As described by Myers (2010), players tend not to learn much from games that permit too much free exploration, particularly "sandbox" games that allow a lot of leeway on choosing one's courses of action. This is because while such games may well have repetitive tasks (like most of them do), they are not really iterative as learning tools. For that purpose, they are too unfocused.

Secondly, as will be discussed below, players usually develop the necessary skills and competences to learn, use, and explore the game environment (Bogost 2007), but unless special effort is made, the learned elements rarely translate into real-world abilities or knowledges. They stay as contextualized skills that are not adapted into other settings by the learner (as per Kim 1993). Tying into this issue is the fact that such games rarely have any pregame briefing (while they do have tutorials and built-in training systems) and almost never have a proper debriefing. As simulation/game studies have shown us, this lack of sufficient pre-framing and debriefing effectively means that their learning results can be flawed or obsolete at best, at worst possibly even harmful (e.g., Crookall 2010; Henriksen 2008).

Since game environments are to some extent configurable (as per Thavikulwat 2004), one would be tempted to configure such a game environment for learning processes. While some rare exceptions (e.g., turning Minecraft into MinecraftEdu, a learning tool) tell us that this is possible, we believe it is far more difficult than consultants, and scholars touting gamification might wish us to believe (see, e.g., Werbach and Hunter 2012). This is because when we are dealing with massively multiple online games, we are dealing with more than just one information system. These systems are all interlinked, forming a functional whole. It is therefore necessary to first look at how the systems function on their own and together, before it is possible to analyze how these types of games can be utilized for organizational learning purposes. In this, we continue the work of Harviainen et al. (2014), who point out that by failing to understand how the social and competitive aspects of play may differ from the intended use of a simulation/game system and that there is more than just the one designed system present at play, users of games as learning tools may be teaching the wrong things.

This is a metatheoretical work, which builds upon a still small but actively expanding tradition of analyzing information phenomena in games. By combining the findings of already existing empirical works (e.g., Vesa 2013; Warmelink 2014), we bring forth new, emergent data (as per Galliers 1992). Using it, we answer the research question “what impact does the information systemic structure of MMORPGs have on their usefulness as organizational learning tools, and what does that imply for simulation/games and their deployment?” By doing so, we propose a conceptual framework of systemic awareness that enables the designers and users of multiplayer games for organizational learning purposes to better understand their tools and to expand the learning acquired by individual players to benefit the entire organization.

2 The Three-Layer Information System

In systemic terms, MMORPGs consist of three interconnected information systems, which together form one larger one. At the center is the coded system, which Harviainen and Savolainen (2014) call the *retrieval core*. This is because the system effectively functions like a library or archival database: the designers input content into it, and then the users (players) retrieve that content through play. Instead of search keywords, they are using game elements such as monsters, items, and spells as their data retrieval tools, but the principle is exactly the same. The code defines the natural laws of the play environment, where its borders start and end and what sorts of interaction with the embedded data content are possible (Jørgensen 2013). Because of the representational forms that the retrieval tasks have, the activities feel “fantastically real,” and they take on an experiential meaning (Hamari and Eranti 2011). For example, engagement with a draconic “boss” monster is for the players more “fighting a dragon” and less “we are learning to respond to an algorithm” (Vesa 2013). The very experientiality of information is a central element of why people interact with virtual worlds, especially when that experientiality can be shared with other users (Kohler et al. 2011).

On top of that retrieval core is the social information system formed by the players, who work in groups, interact with each other, and provide each other with information. This level then extends into a third system, as players produce material (wikis, walk-throughs, YouTube videos, etc.) that relates to play and describes it, but exists outside of the game environment proper. That material, in turn, is used as an addition to self-discovered content within the second system (Harviainen and Savolainen 2014). In fact, the game would not even function in the first place without sufficient information that the players bring with themselves from outside of the play (Crookall et al. 1987; Harviainen et al. 2012): playing conventions, concepts like “money” or “trade,” and so forth, as well as the possibility for inventing missing pieces of world knowledge, if such do not exist. These directly correspond with Land’s (1992) assessment that people using information systems have in truth three simultaneous information sources: (1) a designed information

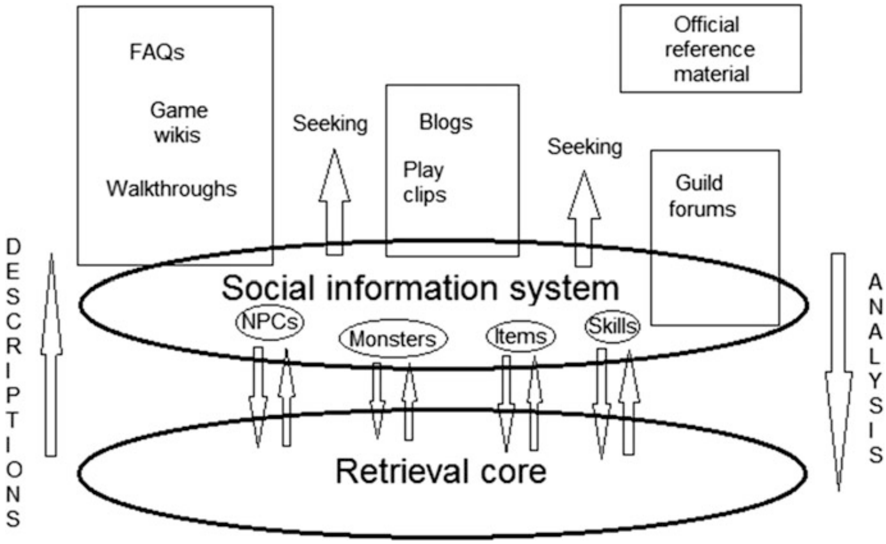

Fig. 1 Example of the three information systems and their key uses in a MMORPG. Players analyze interactions with the retrieval core and create descriptions based on their analyses. Most of the descriptions exist outside the social system level, but their content is re-utilized there by others

system (in MMORPGs, the retrieval core), (2) an informal system constituted of the designed system's users (in MMORPGs, the players), and (3) the "real" (i.e., systems external) world. As noted by Klabbers (2009), the last of these functions as a referent for also fantastic content, and without it, efficient use of the other systems would not be possible (Harviainen and Hamari 2015). Games rely so strongly on existing conventions, which they cannot fully explicate (Fig. 1).

Buckland (1991) divides information systems into two key types, those that simply supply information that is stored in them and those that actually lead their users to becoming informed in the wider sense. The retrieval core of an MMORPG is an information-supplying system that retrieves information, in the form of also items and monsters, whereas the social system formed by the players is a system of becoming informed, with emergent properties, and one with which the users engage in a cognitive manner. Likewise, Buckland (ibid.) further defines information systems' aspects by purpose: cognitive systems aspects lead to users becoming informed, managerial and political systems aspects aggregate and supply information, and economical aspects determine whether the use of the system as a whole is worth the users' time and effort. In many information systems, both social and technical, all three categories are simultaneously present, and they can strongly overlap. This is especially true of MMORPGs, due to their structure and scope (Harviainen and Hamari 2015). As a result, understanding the play processes – and thus their learning implications – sufficiently well is very hard, which is why much research on games just concentrates on singular facets, not the systems' entirety

(Sköld et al. 2015). We believe that this is also a key reason why we still know so little about how social game-based organizational learning actually takes place.

3 Procedural Literacies: Learning to Read and Use the Systems

Games are always simultaneously designed artifacts and the emergent play processes that the artifacts enables (Wardrip-Fruin 2009). When one designs a game, one also designs the parameters of what kinds of play are possible with it. The artifact is what enables the activities and rules relating to it and what makes them meaningful, yet without engagement by one or more users, the system does not become actualized at all (Klabbers 2009). Land (1992) has argued that technical information systems are always extensions of already existing social information systems and networks and are embedded in them. Multiplayer games, however, appear to be an exception to this, because without the artifact at the core, the social information system would not exist at all (Harviainen and Hamari 2015). This is both a key advantage and a hindrance in the use of such games for organizational learning. On the one hand, the lack of (or reduced influence of) a social root makes the games more configurable, and they allow teachers and designers to preselect certain parameters in order to foster and facilitate learning. On the other hand, the games are imperfect creations, in that they are essentially grounded in their own logics rather than those of the real world. Both players and educators have to be able to cross that barrier and adapt game-learned useful ideas not only to contexts outside of play but sometimes organizationally widely so. This task is made possible by the use of procedural literacies.

Following Gee (2007), Bogost (2007) considers procedural literacies to be the abilities one develops in order to learn a (playable) system, its uses, and its applications and then compare it with other systems. It is what enables players to learn from the games, in addition to learning how to play them. Games can facilitate the process by having effective inbuilt tutorials and by utilizing existing conventions (e.g., many real-time strategy games use the same controls as do older ones, thus making it easier for fans of the genre to pick up new games as well). The tutorials and similarities however train one to use the system, not to understand its sets of references in the real world. As a result of this, they can lead to game-effective but otherwise illogical decisions. For example, Palmunen et al. (2013) describe players hoarding resources in a business simulation just to deny them from other players. In Bloom's (1956) classic criteria, this is not learning, but analyzed through Bogost's (2007) description of procedurality, it makes a lot of sense – even as it may not have been the most efficient strategy actually available for those players.

Players also prefer not to disrupt the play experience too much, even to solve information gaps. As a result, in online multiplayer game environments, the influence of cognitive authorities increases (Harviainen and Savolainen 2014). Cognitive authorities are people or groups considered by others to be "in the know" about a certain domain-specific situation or environment, whether they actually have such expertise or not (Wilson 1977). Depending on context and expertise, they can benefit or harm a learning experience, because information that is gained from them is readily accepted as knowledge by those who accept their authority. The combination of reliance on reliable-seeming yet potentially unreliable second-hand sources, the ability to access information sources from outside of play even during play (Adams 2009), and the continually developing but potentially biased procedural literacies (Harviainen et al. 2014) create a situation in which players are likely to master the system but not understand exactly how it actually works. Thus, they are not able to compare it with other systems and contexts, unless properly debriefed. In this, MMORPGs are no different from simulation/games. Both can in optimal circumstances provide useful learning beyond the game as a system, but it is not guaranteed unless properly debriefed (Whitton 2014). An efficient debriefing can change the situation drastically, as can the opportunity to find applicable grounds for adapting the learned ideas into something in one's work or everyday life. To facilitate this, organizations should prepare to both discuss learning by its members in other context and create tools for taking advantage of such serendipitous events. Even this, however, can be insufficient, as the integration of external learning needs not just integration but also expansion. For this to take place, strategic practices created for that expansion are necessary, so we next turn to examining how players handle those practices.

4 Strategizing Procedural Literacies and Learning

How exactly do individually learned skills and practices then become organizational, guild-wide learning that supports and utilizes its members' procedural literacies? We believe that the answer lies in the way guilds and corporations strategize. In choosing to apply collaborative information seeking, use information and communication technologies for coordination, and in training together the groups are both developing strategic practices for expanding their members' procedural literacies and deploying those practices into action. The core challenge to the situation comes from the conflict between efficiency and voluntariness: to really excel at tasks like guild raiding (a type of high-end MMORPG play in which a large group of players attempts to take down a powerful boss monster), the necessary coordination, training, and commitment required are very work-like, yet membership in the guild is voluntary and players have very different amounts of time that they can and want to contribute (Vesa 2013; Milik 2015). Effectively, whereas the raids require strongly transactional leadership, most other facets of guild activities can only be handled through benevolent transformational practices (Prax 2010). Similarly, EVE corporation leaders manifest this duality when they express their dominant positions and demands for member loyalty through persuasive language (Milik 2015).

Rather than having an explicated top-down strategy for organizational learning, MMORPG organizations tend to manifest their strategic thinking through adaptive practices of strategizing. When discussing strategizing as part on game-based learning, the meaning of the word strategizing differs somewhat from its original management studies context (see, e.g., Williamson 1991; Floyd and Lane 2000; Whittington 2003). Here, strategizing refers to processes through which guilds and corporations analyze, synthesize, operationalize, and disseminate play experiences in order to enable in-game performance. We also understand performance in a wide sense, emphasizing that its contents reflect the idiosyncratic values and norms of guilds and corporations, which are likely to substantially differ between group types. We follow conceptualizations of strategizing as something that people do (Whittington 2006). We do not consider it to be exclusive to organizational leadership such as guild officers but rather recognize that it can and does occur throughout organizations (Jarzabkowski et al. 2007).

Most of persistent organizations in MMORPGs (such as World of Warcraft guilds and EVE corporations) display characteristic of classical hierarchies, blending those with idiosyncratic playful elements. Such elements include an appreciation of uncertainty and contingency planning, agility gained from awareness of the organization's goals, equal opportunities for action, collegial teaching, conviviality, and merit-based advancement (Warmelink 2014, pp. 34–46). As organizations, they operate using a number of ongoing, commonplace managerial practices such as recruitment, disciplining, and resource allocation (Vesa 2013). Thus, like in a conventional organization, the way in which learning accrues strategic meaning in the day-to-day affairs of guilds and corporations reflects the values, norms, and capabilities of the organization. Specifically, the need for strategized learning in MMORPGs can be examined through two highly distinct but constantly recurring in-game situations. Firstly, reflecting the high personnel churn of guilds and corporations, how can post-recruitment induction be accomplished so that new recruits can be brought up to speed in order for them to function as effective organizational members? And secondly, how to develop and apply a body of organizational heuristics that helps the organization to understand novel strategic and tactical challenges, such as a new boss encounter, by drawing on previous play experiences of potentially similar encounters?

Examining the first question, the induction problem essentially entails the dissemination of organizational knowledge from senior members to new recruits. This is typically done using two distinct channels, one vertical and one horizontal. The vertical dissemination is operationalized through mentorship. For the duration of a new member's trial or test period, the trialing recruit is usually assigned an experienced personal mentor who is a senior member. The mentor has accrued synthesized knowledge of both the general capability-based demands imposed on playing, such as how to play a given character class in a specific function, as well as idiosyncratic knowledge of how the guild or corporation handles specific in-game situations, such as a boss encounter (Warmelink 2014). The strategized learning takes place through constant interaction in which the senior member mentors the recruit, simultaneously supporting the new recruit but also monitoring his or her ability to adapt to the playing style of the organization. The relationship is typically formal, and it carries with it distinct power implications in the sense that the mentored is expected to obey the mentor's advice. This is typically a one-way dissemination relationship, but analytical work can still occur in limited areas such as gaining an understanding of the minimum in-game gearing required to be able to play a given encounter.

In contrast, horizontal guidance is structured around belonging to a specific group, such as playing a warlock (a magic-using character class specializing in death) in World of Warcraft. Horizontal guidance is informal and non-structured and is based on group identities formed through belonging to a specialized group with dedicated in-game and off-site communication tools such as chat channels or discussion board sections (see Harviainen and Savolainen 2014). Horizontal dissemination happens through spontaneous and informal interaction on these restricted channels and typically has no direct power implications. Indirect power implications, in turn, become manifest in the need to support group rapport and cohesion. This is inductive of creating an in-group, within which a distinct ethnocentricity prevails. Being able to enter these microcultures allows a recruit to interact with senior organizational members on a much more equal footing (Vesa 2013). It enables immersion into playing the class and opens up a forum where a new member can informally ask for opinions and advice on specific encounters and playing styles. Potentially, it also gives the new member a bit of social capital by allowing him or her to build up an initial connection network inside the organization (Warmelink 2014).

Turning to the second question, heuristics relate to the cognitive frames (Kaplan 2008) available to in-game organizations as they undergo sensemaking (Weick et al. 2005) when confronted with new in-game challenges. While substantial amounts of public material and analysis typically exist on the Internet regarding how to play different in-game encounters, it is still a recognized fact among gamers that one cannot simply take a pre-written tactics guide and implement it directly and without adaptation. Every new in-game challenge requires a distinct amount of organization-specific learning, and such learning is heavily guided by the organization's past experiences. One of the key manners in which guilds operationalize this is by creating a repertoire of guild-specific truisms, such as "hey guys, this stomp is just like that on encounter X, just that it has a wider radius" or "Well, it's a dragon so it's bound to have a frontal cone attack." Novel realizations are thus iterated against a collective understanding of how similar events were handled in the past. These heuristics are often treasured by the organization's core members who become living carriers of institutionalized myths (Myer and Rowan 1977). The heuristics can also relate to how the organization understands its own capabilities, such as "in our group it's the mages who deal all the damage" or "we've yet to see phase 2 with more than one druid alive." Such heuristics function as high-speed analytical devices that exploit existing and ingrained responses, but they can also prevent progress if a particularly strong heuristic leads to a sustained misinterpretation of a given situation.

Thus, particularly in leading-edge guilds, heuristics are moderated by analytics, that is, the collection and patterning of both player observations and raw data provided by the game client in order to identify the specific mechanics (i.e., retrieved core content) relating to each novel encounter. Analytics becomes more critical as the challenge levels of encounters increase, because the quick but potentially imprecise nature of operationalized heuristics is not able to produce results in situations where the marginal for success is small and the need for encounter-specific competence is high. Such analysis is usually associated with formal codification. This often happens off-site on discussion boards, i.e., on the external information system level, where organizational members iterate "how we play this encounter" in light of accumulating learning. They blur the functional lines between the three information systems, by analyzing the optimal social level responses to the retrieval core's challenges and by using an external information platform to perform that analysis and distribute its findings.

Furthermore, while each given challenge might have highly restricted options regarding the way it can be tackled, codification is still important because it formalizes the outcome of guild-specific strategic learning. Sometimes, this codification leads to the generation of proprietary code, for example, when EVE guilds devise corporation-specific Excel sheets for tracking warehouse stocks, orders, and cash flows or when World of Warcraft raid guilds (guilds interested in high-end, high-performance content) program their own in-game apps to, for example, track critical event-related timers based on their own analytics. With efficiency in mind, these voluntary organizations grow more and more work-like. As a result, their practices also become more observable, which in turn offers advantages for organizational learning, in the form of increasingly shared communication forms and information practices.

It is here that we especially see the way in which MMORPG organizations apply the tools for organizational learning. As summarized by Morgan (2006), organizations that have learned how to learn have developed abilities to question and change their practices and assumptions, to analyze their environments, to alter their structures as needed, and, especially important here, to learn in a systemic rather than linear fashion – i.e., in double-loop rather than single-loop ways (as per Argyris and Schön 1978). The game environment's artificiality enables members to hone their procedural literacies through constant engagement with all three information system layers and to distribute the fruits of that labor. Strategic practices ensure that individual learning really takes place, that it does not remain context specific, and that its results are shared. These are the key requisites for efficient organizational learning (Kim 1993). The artificiality of MMORPGs and the voluntary yet often serious nature of their use together make them particularly interesting as learning environments, because in them, the processes we also see in other everyday life organizations are particularly visible.

5 Implications for Simulation/Gaming

Duke (1974) has argued that gaming is a future's language, because it has a particular ability to convey entire gestalts rather than just individual concepts. Due to that potential, simulation/games are used in education and training for not just individuals but often organizations. In MMORPGs, players form groups to use the game systems efficiently (Vesa 2013; Warmelink 2014), just like people tend to use more mundane information systems together rather than alone, in an organized manner (Land 1992). From the learning that takes place in MMORPGs, we can understand some of how learning from social games translates into real-world practices – or why it does not. One key reason for the non-translation is that what works (and is enjoyable) in a game setting, e.g., the playful elements present in guild organizing, may not be something people would like to see in their real-world work environments (Warmelink 2014). Another one is that levels of organizational commitment may differ both within and between environments: people may, for example, be primarily committed to their close group but not any wider organizational goals while in a game environment, yet prefer the organizational level (or just their own personal interests) at work, or vice versa (Vesa 2013). This leads to not just different types of strategizing but also different learning processes. While basically a massive challenge, clever organizations can actually use this diversity to learn more, possibly moving them beyond just adapting and into more holistic organizational renewal.

March (1991) describes two directions of organizational learning: exploration, where the organization learns from or through its members, and exploitation, in which the members learn from the organization. In MMORPGs, the players, when they apply their procedural literacies, are not just learning to play. They are exploiting the game as a learning space. Within it, they are able to try out different decision strategies, tactics, and practices – and fail safely as they do so (Tsuchiya and Tsuchiya 1999). This, in turn, becomes exploration by proxy for the organizations of those players, in both the virtual and the real-world settings. Organizations, just like individuals, learn from failing in a fruitful manner (Shepherd et al. 2011). Furthermore, whereas many games, including simulation/games deployed for educational purposes, can by their framing as "games" cause players to become overly competitive and thus lose the benefits of proper experimentation and reflection (Carlson and Misshauk 1972; Harviainen et al. 2014), MMORPGs by their triple systems structure promote learning and sharing together (Harviainen and Savolainen 2014). Their multisystem nature, once understood by players, facilitates double-loop learning because those interacting with the game have to understand the consequences of their actions on several system layers at the same time. The question is therefore not whether the organizations learn through their members' play but rather whether they will be able to adapt that learning for their actual needs.

Organizational learning has a tendency to stay on the individual level, unless special measures are taken to spread and adapt it (Kim 1993; see also Fiol and Lyles 1985). Unless helped, people fall into what Huysman and de Wit (2002) call the "individual learning trap": hoarding what they know due to either laziness or in order to sustain a competitive advantage over their colleagues. The same thing has been detected in MMORPG environments (Lisk et al. 2012). Individual learning in an organizational context is usually expanded by training the members' organizational skills. Learning on the level of the entire organization, however, requires organization-wide understanding, which has to be built, and environmental interpretation of that which is learned. If organizations focus on the way in which players adapt that which they learn into actual practice, they gain a convergent learning process that benefits from its divergent roots. The key to this process is in procedural literacy, which in management terms can be seen as the ability to liquefy information (i.e., separate information from a physical form; Lusch et al. 2010) from the game environment and its related networks and then to also utilize it. This is a kind of "uncommon knowledge" (as per Nag and Gioia 2012) that a clever organization can put to efficient use. It allows players to think differently during play and yet use the results of that experimentation elsewhere, especially once they are past the novice stage (Palmunen et al. 2013). The fact that game organizations have to also allow their own members to exploit their current pools of knowledge (Crossan et al. 1999) adds to this, as it makes sure that the exploitation of other informative environments is sufficiently compared and contextualized with the organization's current state.

Central to the learning process is the players' ability to coordinate and strategize also outside of the game context proper. The MMORPG functions as the focal point of the players' learning, motivating them to acquire, procedurally analyze, expand, and then adapt new skills and knowledges, first to the gaming context and then possibly also beyond it. By fostering such processes also in the context of multiplayer simulation/games, through both assisting in the development of procedural literacies and in the optimized deployment of briefing and debriefing, we can apply similar motivating and adaptability-forming practices to also more formal uses of games as learning tools. Based on the evidence, we believe that smart organizations should use both types of organizational learning through games and integrate their results into their everyday strategic practices. As the gamification of culture increases, organizations that cannot do so are unlikely to survive for long.

6 Conclusions

Skills and knowledges acquired through voluntary play can be brought to use in a wider context. For this to happen, organizations need to learn how to expand upon the procedural literacies of their playing members. This will bring them necessary traits that they need to survive in the ever-evolving market. Lusch and Vargo (2014, pp. 149–151) list five competencies that corporations require in order to hold and sustain a competitive advantage in a network economy. MMORPGs teach all of those: players learn how to collaborate; how to absorb new information and knowledge both in the game itself and the environment surrounding it; how to adapt and adjust when circumstances change; how to use resources effectively, so as to create further value for the play with which they engage; and, most importantly of all, how to learn more.

Simulation/gaming needs to harness this potential further than it so far has. While they may lack the production resources and massive player bases of MMORPGs, and thus certain opportunities for fostering procedural literacies through interaction and highly engaging sensory environments, simulation/games can still utilize some of the same processes, as well as contribute to the voluntary learning that is taking place in MMORPGs. The key to the process is in the correct application of the tools of simulation/gaming to the new topic. Through briefing and debriefing, educators can help players understand which parts of their interaction with each information system – retrieval, social, or expanded – they can adapt elsewhere and how. Players will be open to such an approach, we believe, as they already strategize their organizational learning practices within and relating to the play. If real-world organizations can offer a motivating way for bringing the learning and adaptability also to other contexts, they will gain a significant competitive advantage.

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References

Adams, S. S. (2009). What games have to offer: Information behavior and meaning-making in virtual play spaces. *Library Trends, 57*(4), 676–693.

Argyris, C., & Schön, D. A. (1978). *Organizational learning: A theory of action perspective*. Reading: Addison-Wesley.

Bloom, B. S. (1956). *Taxonomy of educational objectives, handbook 1: The cognitive domain*. New York: David McKay.

Bogost, I. (2007). *Persuasive games: The expressive power of video games*. Cambridge, MA: The MIT Press.

Buckland, M. (1991). *Information and information systems*. New York: Praeger.

Burns, A. C., Gentry, J. W., & Wolfe, J. (1990). A cornucopia of considerations in evaluating the effectiveness of experiential pedagogies. In J. W. Gentry (Ed.), *Guide to business gaming and experiential learning* (pp. 253–278). East Brunswick: Nichols/GP.

Carlson, J. G. H., & Misshauk, M. J. (1972). *Introduction to gaming: Management decision simulations*. New York: Wiley.

Castronova, E. (2005). *Synthetic worlds: The business and culture of online games*. Chicago: University of Chicago Press.

Crookall, D. (2010). Serious games, debriefing, and simulation/gaming as a discipline. *Simulation & Gaming, 41*(6), 898–920.

Crookall, D., Martin, A., Saunders, D., & Coote, A. (1986). Human and computer involvement in simulation. *Simulation & Gaming, 17*, 345–375.

Crookall, D., Oxford, R., & Saunders, D. (1987). Towards a reconceptualization of simulation: From representation to reality. *Simulation/Games for Learning, 17*(4), 147–171.

Crossan, M. M., Lane, H. E., & White, R. W. (1999). An organizational learning framework: From institution to intuition. *Academy of Management Journal, 24*(3), 522–537.

Duke, R. D. (1974). *Gaming: The future's language*. New York: Halsted Press.

EVE Online. CCP Games, 2003.

Fiol, C. M., & Lyles, M. A. (1985). Organizational learning. *The Academy of Management Review, 10*(4), 803–813.

Floyd, S. W., & Lane, P. J. (2000). Strategizing throughout the organization: Managing role conflict in strategic renewal. *Academy of Management Review, 25*(1), 154–177.

Galliers, R. D. (1992). Choosing information systems research approaches. In R. D. Galliers (Ed.), *Information systems research: Issues, methods and practical guidelines* (pp. 144–162). Oxford: Blackwell Scientific.

Gee, J. P. (2007). *What video games have to teach us about learning and literacy* (Rev. upd. ed.). New York: Palgrave Macmillan.

Hamari, J., & Eranti, V. (2011). *Framework for designing and evaluating game achievements*. Proceedings of Digra 2011 conference: Think design play, Hilversum, Netherlands, September 14–17 2011.

Harviainen, J. T., & Hamari, J. (2015). Seek, share, or withhold: Information trading in MMORPGS. Forthcoming. *Journal of Documentation*, *71*(6).

Harviainen, J. T., & Savolainen, R. (2014). Information as capability for action and capital in synthetic worlds. *Information Research*, *19*(4), ISIC paper 12.

Harviainen, J. T., Gough, R. D., & Sköld, O. (2012). Information behavior in game-related social media. In G. Widén & K. Holmberg (Eds.), *Social information research* (pp. 149–171). Bradford: Emerald.

Harviainen, J. T., Lainema, T., & Saarinen, E. (2014). Player-reported impediments to game-based learning. *Transactions of the Digital Games Research Association, 1*(2), 55–83.

Henriksen, T. D. (2008). Extending experiences of learning games: Or why learning games should be neither fun, educational or realistic. In O. Leino, H. Wirman, & A. Fernandez (Eds.), *Extending experiences: Structure, analysis and design of computer game player experience* (pp. 140–162). Rovaniemi: University of Lapland.

Huysman, M., & de Wit, D. (2002). *Knowledge sharing in practice*. Dordrecht: Kluwer Academic.

Jarzabkowski, P., Balogun, J., & Seidl, D. (2007). Strategizing: The challenges of a practice perspective. *Human Relations, 60*(1), 5–27.

Jørgensen, K. (2013). *Gameworld interfaces*. Cambridge, MA: The MIT Press.

Kaplan, S. (2008). Framing contests: Strategy making under uncertainty. *Organization Science, 19* (5), 729–752.

Kim, D. H. (1993). The link between individual and organizational learning. *Sloan Management Review, 35*(1), 37–50.

Klabbers, J. H. G. (2000). Learning as acquisition and learning as interaction. *Simulation & Gaming, 31*(3), 380–406.

Klabbers, J. H. G. (2009). *The magic circle: Principles of gaming & simulation* (3rd. Rev. ed.). Rotterdam: Sense Publishers.

Kohler, T., Fueller, J., Matzler, K., & Stieger, D. (2011). Co-creation in virtual worlds: The design of the user experience. *MIS Quarterly, 35*(3), 773–788.

Lainema, T. (2009). Perspective making: Constructivism as a meaning-making structure for simulation gaming. *Simulation & Gaming, 40*(1), 48–67.

Land, F. (1992). The information systems domain. In R. D. Galliers (Ed.), *Information systems research: Issues, methods and practical guidelines* (pp. 6–13). Oxford: Blackwell Scientific.

Lehdonvirta, V., & Castronova, E. (2014). *Virtual economies: Design and analysis*. Cambridge, MA: The MIT Press.

Leigh, E., & Tipton, E. (2014). What is being simulated. In W. C. Kriz (Ed.), *The shift from teaching to learning: Individual, collective and organizational learning through gaming simulation* (pp. 12–23). Bielefeld: W. Bertelsmann.

Lisk, T. C., Kaplancali, U. T., & Riggio, R. E. (2012). Leadership in multiplayer online gaming environments. *Simulation & Gaming, 43*(1), 133–149.

Lusch, R. F., & Vargo, S. L. (2014). *Service-dominant logic: Premises, perspectives, possibilities*. Cambridge: Cambridge University Press.

Lusch, R. F., Vargo, S. L., & Tanniru, M. (2010). Service, value-networks, and learning. *Journal of the Academy of Marketing Science, 38*(1), 19–31.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71–87.

Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology, 83*(2), 340–363.

Milik, O. (2015). Virtual warlords: An ethnomethodological view of group identity and leadership in EVE Online. *Games & Culture*, OnlineFirst.

Minecraft. Mojang, 2009.

MinecraftEdu. TeacherGaming, 2014.

Morgan, G. (2006). *Images of organization* (Updated ed.). Thousand Oaks: Sage.

Myers, D. (2010). *Play redux: The form of computer games*. Ann Arbor: University of Michigan Press.

Nag, R., & Gioia, D. A. (2012). From common to uncommon knowledge: Foundations of firm-specific use of knowledge as a resource. *Academy of Management Journal, 55*(2), 421–457.

Palmunen, L.-M., Pelto, E., Paalumäki, A., & Lainema, T. (2013). Formation of novice business students' mental models through simulation gaming. *Simulation & Gaming, 44*(6), 846–868.

Prax, P. (2010). Leadership style in World of Warcraft raid guilds. In *Proceedings of DiGRA Nordic 2010: Experiencing games – games, play, and players.*

Shepherd, D. A., Patzelt, H., & Wolfe, M. (2011). Moving forward from project failure: Negative emotions, affective commitment, and learning from the experience. *Academy of Management Journal, 54*(6), 1229–1259.

Sköld, O., Adams, S., Harviainen, J. T., & Huvila, I. (2015). Studying games from the viewpoint of information. In P. Lankoski & S. Björk (Eds.), *Game research methods* (pp. 57–73). Pittsburgh: ETC Press.

Thavikulwat, P. (2004). The architecture of computerized business gaming simulations. *Simulation & Gaming, 35*(2), 242–269.

Titton, L. (2014). The relation between individual, collective and organizational learning through business games in the management field. In W. C. Kriz (Ed.), *The shift from teaching to learning: Individual, collective and organizational learning through gaming simulation* (pp. 224–245). Bielefeld: W. Bertelsmann.

Tsuchiya, S. (2014). "Gaming: the future's language" in organizational learning setting: A Japanese experience. In R. D. Duke & W. C. Kriz (Eds.), *Back to the future of gaming* (pp. 111–123). Bielefeld: W. Bertelsmann.

Tsuchiya, T., & Tsuchiya, S. (1999). The unique contribution of gaming/simulation: Towards establishment of the discipline. In D. Saunders & J. Severn (Eds.), *The international simulation & gaming research yearbook: Simulations & games for strategy and policy planning* (pp. 46–57). London: Kogan Page.

Vesa, M. (2013). *There be dragons: An ethnographic inquiry into the strategic practices and process of world of warcraft gaming groups*. Doctoral dissertation, Hanken School of Economics.

Wardrip-Fruin, N. (2009). *Expressive processing: Digital fictions, computer games, and software studies*. Cambridge, MA: MIT Press.

Warmelink, H. (2014). *Online gaming and playful organization*. New York: Routledge.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science, 16*(4), 409–421.

Werbach, K., & Hunter, D. (2012). *For the win: How game thinking can revolutionize your business*. Philadelphia: Wharton Digital Press.

Whittington, R. (2003). The work of strategizing and organizing: For a practice perspective. *Strategic Organization, 1*(1), 117–125.

Whittington, R. (2006). Completing the practice turn in strategy research. *Organization Studies, 27* (5), 613–634.

Whitton, N. (2009). *Learning with digital games. A practical guide to engaging students in higher education*. New York: Routledge.

Whitton, N. (2014). *Digital games and learning: Research and theory*. New York: Routledge.

Williamson, O. E. (1991). Strategizing, economizing, and economic organization. *Strategic Management Journal, 12*(S2), 75–94.

Wilson, P. (1977). *Public knowledge, private ignorance: Toward a library and information policy*. Westport: Greenwood.

World of Warcraft. Blizzard Entertainment (2004).

An Experiment: An International Comparison of the Decision-Making Process Using a Business Game

Chiaki Iwai and Mitsuru Morita

Abstract Our research team took a closer look at the decision-making process in different countries and conducted a comparative analysis of this not only through field surveys involving questionnaires and listening surveys but additionally through the use of game simulation. In the experiment, a business game, using the same scenario for all, was implemented; the process was videotaped; and by text mining an analysis of frequently occurring words was carried out for each person speaking. The three experiments were conducted over approximately 3 hours with students at business schools in Japan, Russia, and Vietnam. The business game used in the experiment was ABG system we developed in 2014 with a scenario which each participating team played the role of a manufacturer producing and selling a high-end camera product like Canon and Nikon brand in a single market. As a result, two hypotheses are supported. In Japan, a group-led decision-making process will be conducted and a business culture that values the harmony of the team over the individual will be seen. In addition, Japan will reflect a culture where male are at an advantage. In Vietnam, the decision-making process will be comparatively group-led. There will be a strong degree of bureaucracy that will be expressed by an emphasis on respective roles. Another hypothesis with regards to Russia was not supported. The group discussion was videotaped, and not only was it possible to perform quantitative analysis by text mining these conversations, but it was also possible to perform qualitative analysis.

Keywords Business game • Decision-making • Experiments • International comparison

1 Introduction

In the world of business, management in cross-cultural environments is becoming increasingly necessary, and compared with Europe and the USA, which have comparatively greater multicultural exchange, countries in Asia – particularly

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East Asia – have a short and limited history of cross-cultural exchange. The countries in Asia can be divided into countries with declining populations that are already industrially advanced, like Japan, South Korea, and Taiwan, and countries with growing populations, like China, India, and Vietnam. Business between these population-declining and population-growing countries is becoming more active. Specifically, the advanced countries are aggressively entering into local areas in the less-advanced countries, building production centers, and capturing markets. As a result, population-growth countries are becoming wealthier, and this is increasing the level of student exchange and migration to the advanced countries, which have become more attractive as labor markets.

Specifically, according to World Population Prospects: The 2012 Revision, the world population in 2015 stands at 7.325 billion people. Asia's population makes up 60 % of that, or 4.385 billion people, with a growth rate of 1.03 %. On the other hand, Japan's population is 127 million people, and with a negative growth rate of −8 % for the last 5 years, Japan cannot escape a shrinking consumer market.

Having entered the twenty-first century under this environment, many Japanese companies are advancing into Asia in search of the new markets that are accompanying the economic expansion in these countries. There are an increasing number of cases where Japanese companies, having established joint-venture companies with local businesses, are running these new businesses with local corporate headquarters. Consequently, while many of the challenges they face involve external factors, such as system-based differences in the laws and institutions in the respective countries, additional friction is also occurring at the management and administrative levels due to differences in business culture and trading customs.

The world is in a "semi-global" state with cultural, institutional, geographical, and economic differences, and it will continue in this state for the next several decades (Ghemawat 2007). Moreover, it has been pointed out that even in the area of international marketing, giant multinational corporations like PepsiCo and Nestle pay attention to local environments and conduct business operations in ways that are suited to the conditions of each respective country. In other words, the capability to respond to local customs that cannot be globalized is itself an essential element for the sustainable competitiveness of companies. There is prominent prior research in the field of international business that compares the business cultures and customs among countries and regions, and clarifies these characteristics. This research is on national cultures and organizations (Hofstede et al. 2010) and includes the GLOBE project (House et al. 2004), which studied 62 regions and countries around the world. This research was conducted mainly using questionnaire surveys given to company senior executives and employees.

Our research team took a closer look at the decision-making process in different countries and conducted a comparative analysis of this not only through field surveys involving questionnaires and listening surveys but additionally through the use of game simulation. The simulations were controlled experiments on organizational dynamism from the viewpoints of noted experimental economists (Morita et al. 2010, 2011; Iwai et al. 2012). There are case studies that use business games for multinational company education and training (Hofstede et al. 2002).

The experiment subjects were adult students in business schools in various countries. In the experiment, a business game, using the same scenario for all, was implemented, the process was videotaped, and by text mining an analysis of frequently occurring words was carried out for each person speaking. In anticipation of the experiment, prior research in decision-making experiments that use business games and prior research of business games in Japan and Russia were reviewed. The following section describes the business game experiment that was conducted with adult graduate school students of Japan, Russia, and Vietnam and the details of the data that was obtained from this.

1.1 Research on Group Decision-Making Using Business Gaming and Business Games in Japan, Russia, and Vietnam

In many experiments which regard business games as a tool for solving group decision-making problems, and attempt to confirm their validity, school instructors acting as educators measure the educational effectiveness of games and compare multiple variables (Dasgupta 2003). Compared with classroom experiments, there are few reports on experiments in laboratories or on practical experiments in nonacademic settings such as corporations (Estes and Smith 1979; Vance and Gray 1967; Wolfe and Box 1988; Wolfe and Chacko 1983; Norris and Niebuhr 1980; Miesing 1982; Affisco and Chanin 1990; Chanin and Schneer 1984; Schroeder and Benbassat 1975; O'Reilly 1982; Keys et al. 1988; Affisco and Chanin 1989; Wolfe et al. 1989).

Business games were introduced to the classroom in Japan at almost the same time as the USA. They gradually spread and came into use at many corporations and universities in the 1980s (Kurosawa 1990; Ichikawa 1993; Shirai 1996). In Russia, business games have been used since the 1990s, and since really coming into vogue in the 2000s, game versions have been developed to suit Russian business models (Wolfe 1991; Faria et al. 1996; Rybalsky & Wolfe 1999; Volkov et al. 2004; Lamont et al. 2005). However, there is few research in Vietnam. Thus there are differences in the history of business game adoption in Japan, Russia, and Vietnam.

2 Outline of the Experiments

The three experiments were conducted over approximately 3 hours with students at business schools in Japan, Russia, and Vietnam. The outline of the business game experiments discussed in this paper is shown in Table 1. Table 2 shows working experiences of subjects who correctly answered questionnaires. The working experiences of three countries are almost the same. But there is a difference in male-female

Table 1 Outline of the experiment using a business game

	Japan	Russia	Vietnam
Experiment location	Tokyo	Tokyo	Hanoi
Subjects	Aoyama Gakuin University (AGU)	Moscow State University (MSU)	Hanoi University of Science and Technology (HUST)
	1st year MBA full-time and flex-time students	2nd year flex-time MBA students	2nd year flex-time MBA students
Number of subjects	97	17	37
Game scenario	Manufacture and sale of a high-end camera	Same as Japan	Same as Japan
Required experiment time	4 hours	3 hours	6 hours
Number of trials	2 (1 practice trial, 1 actual trial)	Same as Japan	Same as Japan
Number of competing teams	24	6	8
Students per team	4 or 5	4	4 or 5
Input variables	Price, marketing, R&D, production volume, capital investment, borrowing	Same as Japan	Same as Japan
Game target variable	Maximizing cumulative profit	Same as Japan	Same as Japan

Table 2 Subjects' profile working experience

		Japan	Russia	Vietnam
Female	Mean	7.13	8.94	9.00
	SD	7.61	5.99	4.22
	N	32	8	14
Male	Mean	10.58	11.25	9.18
	SD	8.55	2.82	6.16
	N	62	8	22
Total	Mean	9.40	10.09	9.11
	SD	8.36	4.68	5.42
	N	94	16	36

ratios. These results reflect the situation of MBA student by each country. Subjects participated for learning purposes, as a part of graduate school classes or preparatory courses, without knowing the purpose of this experiment. The business game used in the experiment was Aoyama-gakuin Business Game (ABG) system we developed in

2014 with a scenario in which each participating team played the role of a manufacturer producing and selling a high-end camera product like Canon and Nikon brand in a single market. The winning team, the one that achieved the largest cumulative profit at the end of the game, received a small prize. Instructors from each country formed the teams in advance, grouping subjects into teams of four or five members each. Each team was given a personal computer for input use, and the instructor informed subjects of the rules and the fact that the best-performing team would receive a small prize. Subject teams held tactical meetings for approximately 20 minutes each to decide on a company name, mission statement, and roles within the team (i.e., president, finance officer, marketing director, production manager, R&D manager). After this meeting, they filled out a questionnaire on cultural dimensions. Following a practice round of the game, a new round of game input and output was conducted from period one to period four, although we did not tell subjects clearly about the number of periods in advance. At every period of the game, each team decided on input variables through meetings of roughly 20 minutes, while looking at the overall rankings and their own companies' financial statements. After completion of the fourth period, the game finished and debriefing was conducted. The subjects answered questionnaires on the group decision-making of their own teams immediately after the game. The process concluded with the announcement of the winning teams.

3 Framework of Analysis

In accordance with the complex adaptive system, we introduce the concepts of subjects, business strategy (and measure of success), and group of subjects as the framework for comparative analysis of group decision-making. Using the concepts above, in this study, we defined subjects, business strategies (and measure of success), and group of subjects as described below:

Subjects: We took profile data of subjects from Japan, Russia, and Vietnam, respectively. The distinguishing features of each were measured immediately prior to the game using a total of 18 questions on cultural dimension based on the GLOBE study. We attempted comparison in our analysis of subjects, taking into consideration the cultural aspects of each country using the cultural dimension based on the GLOBE study (House et al. 2004). The GLOBE study is well known as one of the successor of Hofstede's cultural dimension (Hofstede et al. 2010). It provides the methods for measuring cultural aspects of countries. The GLOBE study shows nine cultural dimensions with huge samples of 17,000 middle managers of 951 organizations in 62 countries. This paper partially uses the GLOBE study's questionnaires and tries to compare eight dimensions of three countries. Here are the definitions of the dimensions:

- Power Distance: The degree to which member of a collective expects power to be distributed equally.

- Uncertainty Avoidance: The extent to which a society, organization, or group relies on social norm, rules, and procedures to alleviate unpredictability of future events.
- Humane Orientation: The degree to which a collective encourages and rewards individuals for being fair, altruistic, generous, caring, and kind to others.
- Institutional Collectivism: The degree to which organizational and societal institutional practices encourage and reward collective distribution of resources and collective action.
- Assertiveness: The degree to which individuals are assertive, confrontational, and aggressive in their relationships with others.
- Gender Egalitarianism: The degree to which a collective minimizes gender inequality.
- Future Orientation: The extent to which individuals engage in future-oriented behaviors such as delaying gratification, planning, and investing in the future.
- Performance Orientation: The degree to which a collective encourages and rewards group members for performance improvement and excellence.

Business strategy: Decision-making on variables, conducted by each team and measured by the input values for each variable and the team's ranking. Here, ranking is defined as a measure of success, maximizing cumulative profit. It is measured using the total ranking report for each quarter as the game progresses.

Group of subjects: This refers to the team itself, made up, in principle, of three or four or five subjects. It is measured using questionnaires on group decision-making immediately after the game. We also choose a good result team of each countries and record video of their discussions during business game. Naturally they discussed using their home languages, that is, Japanese, Russian, and Vietnamese. Then we wrote down all of their discussions into text file and translate them to Japanese, so we can text mine all those discussions. We are interested which business words are frequently used and compared among three countries.

4 Hypotheses

The scenario for the business game was the manufacturing of a high-end camera model that camera makers Canon and Nikon were creating in Japan. In this field, Japan leads the world, with Russia mainly importing these products, since little manufacturing is carried out in Russia domestically. Vietnam is a country moving toward its still unrealized potential as a manufacturing center and a consumer market. If the experiment subjects were to reflect the current global situation, the results of the business game would be as follows:

H1 *Japanese students will have the greatest understanding of the game scenario's business model, and the students will adopt a strategy of product differentiation, like that taken by Canon and Nikon.*

H2 *Russian students will understand the logic of the business game, but with little experience with camera manufacturing, they will not adopt a strategy that reflects the real business model as much as Japan.*

H3 *Vietnam students have little experience with business games. On the other hand, there are students with experience in the manufacturing industry, and as there are many examples of low-price popular mainstream products and contract manufacturing, the students are expected to take a low-cost strategy.*

According to the prior research cited above (Hofstede et al. 2010; House et al. 2004), the business decision-making by each country group will be as follows:

H4 *In Japan, a group-led decision-making process will be conducted and a business culture that values the harmony of the team over the individual will be seen. In addition, Japan will reflect a culture where male are at an advantage.*

H5 *In Russia, the European culture of individual leadership and of large differences in power status will be reflected. The decision-making process will be carried out by a strong leader.*

H6 *In Vietnam, the decision-making process will be comparatively group-led. There will be a strong degree of bureaucracy that will be expressed by an emphasis on respective roles.*

5 Results and Discussions

5.1 Comparison of Japan, Russia, and Vietnam: Subjects

Using the analysis of variance (ANOVA) of the difference between the average values of the three countries in Table 3 (As is) and Table 4 (Should be) and by using Scheffe's multiple comparison, we examined the average difference between country pairs. Subsequently, we see that one of the significant differences among the three countries is that "performance orientation" (BQ1a) in Vietnam is high compared with the other countries. It is especially significantly higher than in Japan. In addition, Vietnam has high "uncertainty avoidance" (BQ9a) compared with the other countries, and again, this is significantly higher when compared with Japan.

Concerning the "Should be" category for "gender egalitarianism" (BQ3b), Japan was lower compared with the other countries, and it was significantly lower when compared with Russia. Moreover, for "assertiveness" (BQ4b), Japan was also lower and was significantly lower compared with Vietnam. For "collectiveness" (BQ5b), Vietnam was comparatively higher than the other countries, and for "humane

Table 3 Comparison of cultural dimension: As is

		Japan	Russia	Vietnam	*F* value	Difference of mean J-R	J-V	R-V
BQ1a performance orientation	Mean	5.24	5.24	5.92	2.99	0.009	−0.674	−0.684
	SD	1.49	1.60	1.30	(0.053)	(1.000)	(0.061)	(0.280)
	N	94	17	37				
BQ2a future orientation	Mean	4.65	4.59	4.46	0.13	0.061	0.189	0.129
	SD	1.96	1.50	2.04	(0.881)	(0.993)	(0.881)	(0.975)
	N	94	17	37				
BQ3a gender egalitarianism	Mean	4.79	5.35	4.86	0.76	−0.566	−0.078	0.488
	SD	1.76	1.69	1.70	(0.468)	(0.468)	(0.974)	(0.633)
	N	94	17	37				
BQ4a assertiveness	Mean	4.65	4.76	5.22	1.46	−0.116	−0.567	−0.452
	SD	1.76	1.60	1.62	(0.235)	(0.968)	(0.236)	(0.668)
	N	94	17	37				
BQ5a collectivism	Mean	3.80	4.71	4.27	2.66	−0.908	−0.472	0.436
	SD	1.58	1.76	1.87	(0.074)	(0.125)	(0.352)	(0.676)
	N	94	17	37				
BQ6a collectivism	Mean	3.71	4.06	4.05	0.55	−0.349	−0.344	0.005
	SD	1.79	2.33	2.08	(0.580)	(0.791)	(0.658)	(1.000)
	N	93	17	37				
BQ7a power distance	Mean	3.50	2.59	3.16	1.75	0.912	0.338	−0.574
	SD	1.94	1.73	1.99	(0.177)	(0.204)	(0.667)	(0.599)
	N	94	17	37				
BQ8a humane orientation	Mean	4.77	3.94	4.89	3.26	0.825	−0.126	−0.951
	SD	1.30	1.64	1.26	(0.041)	(0.067)	(0.888)	(0.055)
	N	94	17	37				
BQ9a uncertainty avoidance	Mean	3.62	3.59	4.41	3.32	0.029	−0.788	−0.817
	SD	1.65	1.54	1.59	(0.039)	(0.998)	(0.046)	(0.231)
	N	94	17	37				

Note: p-value in parentheses

orientation" (BQ8b), Japan was significantly lower when compared with the other countries. Last, for "uncertainty avoidance" (BQ9b), Vietnam was comparatively higher than the other countries, and in particular, a significant difference with Japan could be confirmed. In Japan, there is still a cultural tendency for male bias, and in both, the "Should be" and "As is" cases, "gender egalitarianism" was low. With respect to the "Should be" for "assertiveness," it could be confirmed that Japan maintains the position that it is better to constrain self-assertiveness. On the other hand, Russia was not seen a significant difference with respect to any cultural dimensions. However, for "uncertainty avoidance," it had a lower trend compared with the other countries in both the "As is" and "Should be" cases. Moreover, although "power distance" was high for Russia in the "As is" case in the earlier research by Hofstede and in the GLOBE study, a lower "power distance" was found

Table 4 Comparison of cultural dimension: Should be

					F	Difference of mean		
		Japan	Russia	Vietnam	value	J-R	J-V	R-V
BQ1b performance orientation	Mean	6.17	6.53	6.30	1.04	−0.359	−0.127	0.232
	SD	0.95	0.62	1.18	(0.355)	(0.383)	(0.800)	(0.722)
	N	94	17	37				
BQ2b future orientation	Mean	6.17	5.88	5.86	0.83	0.288	0.305	0.017
	SD	1.20	1.65	1.60	(0.438)	(0.726)	(0.515)	(0.999)
	N	94	17	37				
BQ3b gender egalitarianism	Mean	5.17	6.24	5.27	2.71	−1.065	−0.100	0.965
	SD	1.79	0.97	1.87	(0.070)	(0.071)	(0.957)	(0.171)
	N	94	17	37				
BQ4b assertiveness	Mean	5.13	5.53	5.84	4.89	−0.402	−0.710	−0.308
	SD	1.18	1.01	1.32	(0.009)	(0.446)	(0.011)	(0.680)
	N	94	17	37				
BQ5b collectivism	Mean	4.36	4.76	5.43	6.45	−0.403	−1.071	−0.668
	SD	1.56	1.52	1.48	(0.002)	(0.612)	(0.002)	(0.337)
	N	94	17	37				
BQ6b collectivism	Mean	4.21	4.35	3.51	1.85	−0.140	0.699	0.839
	SD	1.82	2.09	2.33	(0.160)	(0.965)	(0.198)	(0.358)
	N	94	17	37				
BQ7b power distance	Mean	2.68	2.18	3.27	2.25	0.504	−0.589	−1.094
	SD	1.75	1.07	2.42	(0.109)	(0.599)	(0.277)	(0.145)
	N	94	17	37				
BQ8b humane orientation	Mean	4.93	5.71	5.86	9.54	−0.780	−0.939	−0.159
	SD	1.26	0.77	1.18	(0.000)	(0.050)	(0.000)	(0.903)
	N	94	17	37				
BQ9b uncertainty avoidance	Mean	3.28	3.00	4.05	3.49	0.277	−0.777	−1.054
	SD	1.64	1.27	1.93	(0.033)	(0.824)	(0.062)	(0.105)
	N	94	17	37				

Note: p-value in parentheses

in the results from the subjects in this study. For Vietnam, "uncertainty avoidance" was high in both the "As is" and "Should be" cases. For the "As is" case, "performance orientation" was high compared with the other countries, and "collectivism" was high in the "Should be" case, reflecting the belief that "managers should generally encourage group loyalty even if individual goals suffer." However, it was thought that remuneration should be paid to a standard that maximizes individual performance.

5.2 Comparison of Japan, Russia, and Vietnam: Business Strategy

Next, we compare the countries' strategies. In this business game, maximization of cumulative profit is the measure of success. In addition, in the prior explanation of the game, the following expression was explained to subjects from each country:

$$\begin{aligned}\text{Profit} = \; & \text{Revenue (price} \times \text{units sold)} \\ & - \text{Cost (cost of goods sold} + \text{R\&D} \\ & + \text{marketing} + \text{depreciation} + \text{interests)}\end{aligned}$$

Although participating teams employed multiple strategies within this framework, the variables that they could manipulate directly were price, quantity of production, marketing, R&D, capital investment, and borrowing. In this business game experiment, participants were able to get a general feel of the relationship between these variables and profit in the practice round, that is, the relationship between strategy and measurement of success. We first focused on which variables were manipulated by each team, and how, during the initial input in the actual round. We attempted comparison of the differences among the three countries' strategies using tendencies in deciding on initial variables.

Figure 1 shows a comparison by country of the degree to which the initial team decision-making input variables varied from the default values. The Japanese teams' strategy sought to differentiate products by quality, with a somewhat low value for price, a very high degree of importance assigned to R&D, and some importance given to marketing and capital investment. The strategy of the Russian teams ascribed importance to price and capital investment. The strategy of the Vietnam teams is low direct cost strategy, that is, they tend to keep low price and low manufacturing cost.

Table 5 shows the average coefficient of variation of the input variables for each team up until the fourth quarter. Compared with Japan and Russia, Vietnam conducted a stable decision-making process, except in the case of capital investment. For Russia, on the other hand, with the exception of capital investment, the coefficient of variation was large when compared with the other countries, and this can be explained by the input variables changing to correspond with the game's progression. Japan fell in between Russia and Vietnam.

5.3 Comparison of Japan, Russia, and Vietnam: Group of Subjects

In this business game experiment, participants were able to get a general feel of the relationship between these variables and profit in the practice round, which is the relationship between strategy and measurement of success.

Fig. 1 Business game first quarter (period 1) input variables by countries

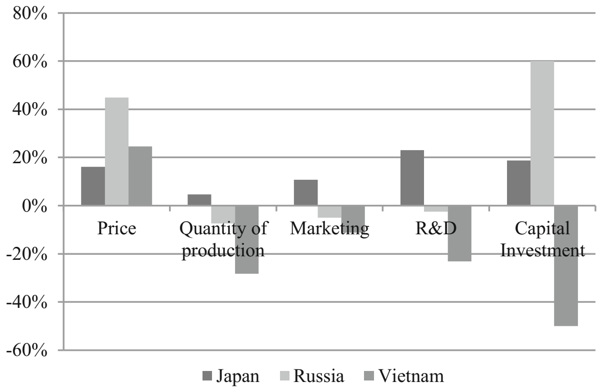

Table 5 Mean of coefficient variation of input variables by each countries

Input variables	Japan	Russia	Vietnam	Average
Price	0.13	0.11	0.08	0.12
Quantity of production	0.19	0.39	0.24	0.23
Marketing expense	0.38	0.43	0.30	0.37
R&D	0.32	0.34	0.33	0.33
Capital Investment	0.74	0.37	0.93	0.73

Table 6 shows the response results for group decision-making after the business game was conducted. We think Japan had a good group decision-making process when compared with the other countries. In addition, rather than having the game carried out by specific individual leadership, the actual decision-making process was evaluated as having been carried out through consultation. As a result, the constrained self-assertiveness of the Japan team was evaluated as good in the cultural dimension of "assertiveness," since decision-making was carried out with importance placed on interpersonal relationships and consensus.

In terms of Russia, there were more conflicting opinions compared with the other countries in the decision-making process during the game. However, evaluation was high concerning their own and other team members' cooperation. Additionally, compared with the other countries, the decision-making process was carried out based on an energetic discourse irrespective of roles.

5.4 *Text Mining of Decision-Making Discussion*

A practice session of the business game was carried out. From this, the best-performing team from each country was selected and the decision-making process in the actual session was videotaped. Conversations were carried out completely in the local language. In other words, the Japanese team spoke Japanese, the Russian team spoke Russian, and the Vietnamese team spoke Vietnamese. For this

Table 6 Mean of coefficient variation of input variables by each countries

Questionnaire		Japan	Russia	Vietnam	*F* value	Difference (Japan minus Russia)	Difference (Japan minus Vietnam)	Difference (Russia minus Vietnam)
AQ1 my cooperation	Mean	5.97	6.35	6.74	6.81	−0.38	−0.77	−0.39
	SD	1.20	0.79	0.78	(0.002)	(0.400)	(0.002)	(0.473)
	N	94	17	35				
AQ2 my role	Mean	4.26	3.82	6.14	17.98	0.43	−1.89	−2.32
	SD	1.74	2.10	1.35	(0.000)	(0.630)	(0.000)	(0.000)
	N	94	17	35				
AQ3 other member's cooperation	Mean	6.19	6.35	5.83	1.08	−0.16	0.36	0.52
	SD	1.27	1.27	1.82	(0.342)	(0.912)	(0.438)	(0.462)
	N	94	17	35				
AQ4 other member's role	Mean	4.31	3.06	5.83	14.14	1.25	−1.52	−2.77
	SD	1.97	2.05	1.54	(0.000)	(0.045)	(0.000)	(0.000)
	N	94	17	35				
AQ5 conflict	Mean	2.65	3.71	2.23	5.62	−1.06	0.42	1.48
	SD	1.33	2.08	1.57	(0.005)	(0.030)	(0.367)	(0.005)
	N	94	17	35				
AQ6 consensus	Mean	6.23	5.12	6.29	6.15	1.12	−0.05	−1.17
	SD	1.13	1.41	1.47	(0.003)	(0.004)	(0.978)	(0.008)
	N	94	17	35				
AQ7 democracy	Mean	5.41	5.24	4.49	3.22	0.18	0.93	0.75
	SD	1.61	1.68	2.45	(0.043)	(0.935)	(0.043)	(0.394)
	N	94	17	35				
AQ8 emergent property	Mean	5.51	5.35	4.74	2.68	0.16	0.78	0.62
	SD	1.51	1.11	2.25	(0.072)	(0.938)	(0.072)	(0.464)
	N	94	17	34				

Note: *p*-value in parentheses

Table 7 The percentage of frequently spoken words in a team Japan

Words	A	B	C	D	Total
Price	4.3	6.3	4.3	0.8	15.6
Share	2	7	3.1	1.2	13.3
Capital investment	4.7	8.6	0	0	13.3
Research and development	3.1	8.6	1.2	0	12.9
Marketing	3.1	3.9	0.4	0.4	7.8
Money	4.3	1.6	0	0.4	6.3
Cash	2	3.1	0.8	0.4	6.3
Profit	1.2	2.7	1.6	0	5.5
Cost	2	2.3	0	0	4.3
Financial statement	2	1.6	0	0	3.5
Deficit	1.2	1.6	0.4	0	3.1
President	0	2.3	0	0	2.3
Product capacity	1.2	0.8	0	0	2
Camera	0.8	0.8	0.4	0	2
Company	0.4	1.6	0	0	2
Total %	32	52.7	12.1	3.1	100

Note: Subjects: A, male, Japanese, flex-time; B, male, Japanese, flex-time; C, female, Chinese, full-time; D, female, Chinese, full-time

experiment, all conversation was written down word for word in the local language and then later translated into Japanese. Subsequently, frequently occurring words (nouns) were extracted by performing text mining on the Japanese translation. The frequencies of the respective commonly occurring words and the person speaking them were recorded in Tables 7, 8, and 9. As the number of words actually spoken was different for each team, the value was expressed as a relative frequency.

The Japanese team was comprised of four members, two Japanese men with comparative business experience and two women with little business experience. The conversations were totally in Japanese. As a result, the largest number of words in the meetings were spoken was by the two men with the two women speaking very little. The top 50 % of the words/phrases spoken by the team were "price," "share," "capital investment," "research and development," and "marketing." Except for "share," these words were input variables that could be managed by players of the game. In addition, although words such as "money," "cash," "profit," and "cost" were also used, these were output variables that expressed a result of management. Based on this, the team seems to have understood the purpose of "maximization of cumulative profits," which was the game's objective, and, accordingly, understood how to give a balanced examination of how to manage the input variables. The content of the discussion in terms of strategy was that either a low-cost strategy that places importance on capital investment or a differentiation strategy that places emphasis on research and development should be taken.

The Russian team was an adult student team with one man and three women. The woman that was the team leader spoke the most, and one of the other women spoke

Table 8 The percentage of frequently spoken words in a team Russia

Words	A	B	C	D	Total
Production	0	10.3	1.1	0	11.5
Price	2.3	5.7	1.7	0.6	10.3
Setting	1.1	6.3	0.6	0.6	8.6
Max	1.1	4.6	1.1	0.6	7.5
Investment	0.6	5.7	1.1	0	7.5
Quarter	0	4.6	1.7	0	6.3
Inventory	0.6	2.9	2.9	0	6.3
Sales	0	5.2	0	0.6	5.7
Calculation	0.6	4.6	0.6	0	5.7
Marketing	0.6	4.6	0.6	0	5.7
Money	0	4.6	0	0	4.6
Capital investment	1.1	1.7	1.1	0	4
Market	1.1	1.7	0.6	0	3.4
Input	0	2.3	0.6	0	2.9
Cash	0.6	0.6	1.7	0	2.9
Product	0	1.1	1.1	0	2.3
Production capacity	1.1	0.6	0	0.6	2.3
Share	1.1	1.1	0	0	2.3
Total %	12.1	68.4	16.7	2.9	100

Note: Subjects: A, female, Russian, flex-time; B, female, Russian, flex-time; C, male, Belarusian, flex-time; D, female, Russian, full-time

Table 9 The percentage of frequently spoken words in a team Vietnam

Words	A	B	C	D	E	Total
Figure	2.5	4.1	0	0	7.5	14.1
Market	0.9	0.6	0.3	0	8.4	10.3
Production volume	0.3	4.1	0.3	0	4.7	9.4
Investment	0.9	3.1	0.3	0	4.4	8.8
Input	1.3	5	0.3	0	0.9	7.5
Price	1.6	2.8	0	0.3	2.8	7.5
Marketing	0.3	2.2	0	0	4.7	7.2
Calculation	0.6	3.4	0	0.3	2.5	6.9
Production	1.3	1.9	0	0	2.8	5.9
Default	1.9	0	0	0	2.8	4.7
Percent	1.3	0.6	0	0	2.5	4.4
Maintain	0.6	0.6	0	0.3	2.2	3.8
Products	0	0.9	0	0.9	1.6	3.4
Money	0	1.6	0.3	0	1.6	3.4
Problem	1.3	0.6	0	0.3	0.6	2.8
Total %	14.7	31.6	1.6	2.2	50	100

Note: Subjects: A, male, Vietnamese, flex-time; B, female, Vietnamese, flex-time; C, male, Vietnamese, flex-time; D, female, Vietnamese, flex-time; E, male, Vietnamese, flex-time the least. The top 50 % of the words spoken by the team were "production," "price," "setting," "max," "investment," and "quarter." The students were interested in what to do to win the game, suggesting that they did not understand the game as a simulation of an actual manufacturing business. Later, an interest was shown in the words "inventory," "sales," "calculation," and "marketing." Additionally, this team put many figures on the table as part of the conversation, which was seen as a method to derive a rational conclusion by analyzing output variables using objective data. On the other hand, words that express product differentiation such as "research and development" and "quality" were not expressed.

The Vietnamese team was comprised of three male and two female adult students. The team's conversations were entirely conducted in Vietnamese even though the instructor's explanation was in English, and the team included students that did not understand English very well. A man who worked as a CEO and a woman who was his partner led the meeting, and there were very few words spoken by C (woman) and D (man). The top 50 % of words spoken by the team were "figures," "market," "production," "volume," "investment," and "input." The team was interested in production and manufacturing. The team appeared to be interested first in what kind of figures to input in order to establish an advantage. The game in Vietnam was conducted over a longer period than the other countries, and the students appeared to understand the scheme of the game. However, words expressing product differentiation such as "research and development" and "quality" did not appear as frequently occurring words.

As shown in the Results and Discussions, assessment was carried out from three points of view: subjects, business strategy, and group of subjects. The hypotheses H1, H2, and H3, relating to understanding of the business model, were all supported. The Japanese team focused on the strategy taken by Nikon and Canon in research and development, while the other countries did not focus as much on product differentiation. In other words, in order to promote an understanding of such a business model beforehand, it may be necessary to hold lectures in these countries where the industry is not yet flourishing and where there are no such examples. Moreover, in terms of the hypotheses about group decision-making, H4 and H6 were supported, but H5 was not.

6 Conclusions

The group discussion was videotaped, and not only was it possible to perform quantitative analysis by text mining these conversations, but it was also possible to perform qualitative analysis. In order to take a closer look at the business culture and group decision-making in different countries, various methods have been attempted. In this experiment, we were able to show it is possible to get a dynamic and multifaceted view by using a business game.

References

Affisco, J., & Chanin, M. (1989). The impact of decision support systems of the effectiveness of small group decisions-an exploratory study. *Developments in Business Simulation & Experiential Exercises, 16*, 132–135.

Affisco, J., & Chanin, M. (1990). The impact of decision support systems of the effectiveness of small group decisions-revisited. *Developments in Business Simulation & Experiential Exercises, 17*, 1–5.

Chanin, M. N., & Schneer, J. A. (1984). A study of the relationship between Jungian personality dimensions and conflict handling behavior. *Human Relations, 37*(10), 863–879.

Dasgupta, S. (2003). The role of controlled and dynamic process environments in group decision making: An exploratory study. *Simulation & Gaming, 34*, 54–68.

Estes, C. A., & Smith, J. R. (1979). Research on the effectiveness of using a computerized simulation in the basic management course. In S. C. Certo & D. C. Brenenstuhl (Eds.), *Insights into experiential pedagogy* (pp. 25–28). Tempe: Arizona State University.

Faria, A. J., Dickinson, J. R., & Peterson, R. (1996). Administering business simulations in transitioning economies: The introduction of simulation gaming to Estonia. *Developments in Business Simulation & Experiential Exercises, 23*, 15–21.

Ghemawat, P. (2007). *Redefining global strategy: Crossing borders in a world where differences still matter* (Vol. 1). Brighton: Harvard Business Review Press.

Hofstede, G. J., Pedersen, P. B., & Hofstede, G. (2002). *Exploring culture – Exercises, stories and synthetic cultures*. Boston: Intercultural Press.

Hofstede, G., Hofstede, G. J., & Minkov, M., (2010). *Cultures and organizations: Software of the mind*. Revised and expanded (3rd ed.). New York: McGraw-Hill.

House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (Eds.). (2004). *Culture, leadership, and organizations the globe study of 62 societies*. Thousand Oaks: Sage.

Ichikawa, A. (1993). The decision making environment for business gaming in information society. *Studies in Simulation and Gaming JASAG, 3*(1), 1–10.

Iwai, C., Horiuchi, M., Morita, M., & Oshima, M. (2012). An analysis of business culture based on complex adaptive systems: -A comparison of group decision-making systems in Japan, China, and Hong Kong. *Studies in Simulation and Gaming JASAG, 22*(Special), 25–38.

Keys, B., Burns, O. M., Case, T., & Wells, R. A. (1988). Decision support package in a business game: Performance and attitudinal effects. *Simulation & Gaming, 19*(4), 440–452.

Kurosawa, T. (1990). A survey of gaming simulation for management education in 40 industrial engineering department. *Studies in Simulation and Gaming JASAG, 1*(1), 89–93.

Lamont, D. L., Volkov, A. E., & Shoptenko, V. V. (2005). International management game-an integrated tool for teaching strategic management internationally. *Developments in Business Simulation & Experiential Exercises, 32*, 175–182.

Miesing, P. (1982). Group processes, decision making styles and team performance in a complex simulation game. In D. J. Fritzche & L. A. Graf (Eds.), *Development in business simulation and experienced exercises* (pp. 228–231). Normal: Illinois State University.

Morita, M., Horiuchi, M., Iwai, C., Oshima, M., & Yu. (2010). An experiment on group decision-making using a business game. *Developments in Business Simulations and Experiential Learning, 37*, 141–150.

Morita, M., Iwai, C., Horiuchi, M., Oshima, M., Yu, & Xu. (2011). A study on collectivism and group decision-making. *Developments in Business Simulation and Experiential Learning, 38*, 66–82.

Norris, D. R., & Niebuhr, R. E. (1980). Group variables and gaming success. *Simulation & Games, 11*(3), 301–312.

O'Reilly, C. (1982). Variations in decision maker's use of information sources: The impact of quality and accessibility of information. *Academy of Management Journal, 25*(4), 756–771.

Rybalsky, V., & Wolfe, J. (1999). Management gaming's lost opportunity: Meditations about the Russian experience and prospects for the future. *Developments in Business Simulation & Experiential Exercises, 17*, 132–137.

Schroeder, R. G., & Benbassat, I. (1975). An experimental evaluation of the relationship of uncertainty in the environment to information used by decision makers. *Decision Sciences, 6*, 556–567.

Shirai, H. (1996). Gaming simulation for problem setting. *Studies in Simulation and Gaming JASAG, 6*(1), 85–92.

Vance, S. C., & Gray, C. F. (1967). Use of a performance evaluation model for research in business gaming. *Academy of Management Journal, 10*(1), 27–37.

Volkov, A. A., Klimov, A. A., Tugaev, M. J., Lysova, S. I., & Shoptenko, V. V. (2004). Teaching public finance management through simulation. *Developments in Business Simulation & Experiential Exercises, 31*, 221–228.

Wolfe, J. (1991). On the transfer of market oriented business games to socialist cultures. *Developments in Business Simulation & Experiential Exercises, 18*, 121–126.

Wolfe, J., & Box, T. M. (1988). Team cohesion effects on business game performance. *Simulation & Gaming, 19*(1), 82–98.

Wolfe, J., & Chacko, T. I. (1983). Team-size effects on business game performance and decision making behaviors. *Decision Sciences, 14*, 121–133.

Wolfe, J., Bowen, D. D., & Roberts, C. R. (1989). Team building study. *Simulation & Gaming, 20*(4), 388–408.

Experiential Artefact for Cross-Cultural Learning in Business Games: First Results

Luiz Antonio Titton and Jose Dutra de Oliveira-Neto

Abstract The use of simulators in higher education is a common practice in many areas of disciplines by virtue of providing a safe environment for experimentation. In management courses, an established type of simulator is the business game, which has characteristics suitable for learning intercultural competences. In management education, the kind of simulators used performs the context of business games. Not only regulatory agencies but also researchers recommend training in this competency. Existing business games do not have tools to manage the didactic learning of these competences. The purpose of this research was to produce an apparatus for managing intercultural learning, for use with business games. The Experiential Artefact of Cross-Cultural Learning Skills (MCCLS) served as a basis to design a system attachable to any business game in the web environment. After the apparatus has been produced, it can be used by students from different cultures. Teachers will be able to use the apparatus to support intercultural learning. The result shows that the apparatus will help in the teaching-learning process by demonstrating to the teacher that there are competence attributes with deficiencies. From these indicators, teachers can act with adequate didactic procedures, as they deem necessary. It is likely, too, that this system is suitable for distance learning, by the availability in the web environment, contributing to the training of top professionals with intercultural competences.

Keywords Networked learning • Management education • Didactic tool • Cross-cultural competences • Business games

1 Introduction

Professionals who work in higher education face the recurring indication that experiential learning techniques are desirable, particularly in the context of distance learning. Practical experience has been recommended as essential for the formation of more able students for professional practice, both by teachers in higher education

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and by education agencies, especially in management learning (Brasil 2002, 2004, 2010; Mintzberg and Gosling 2002; Mintzberg 2005).

Among the various techniques available, virtual labs stand out for their viability for use on the web. Moreover, these devices are gaining academic credibility from the fact that when they reach their occupational activity after their training curriculum, the students will access systems compatible with the virtual reality that contributed to their studies (Gosen and Washbush 2004; Kayes 2002; Mintzberg and Gosling 2002; Morgan et al. 2002; Sims 1978).

From the list of content targeted to professional training, intercultural competence stands out (Avery and Joseph 2004; Giacalone 2004; Mintzberg and Gosling 2002; Toegel and Conger 2003; Van Dyne 2009). The simulators are used in various areas of knowledge, as one among various experiential learning techniques (Issenberg et al. 2005; Satava 2008; Su et al. 2005). Intercultural competence is demanded, in varying degrees, in many fields of knowledge, but, in the particular case of the management education, the demand for this training is presented as essential for professional practice as a result of globalization (Toegel and Conger 2003; Van Dyne 2009; Yamazaki and Kayes 2004). This context has competitive features and involves stakeholders from different cultures in situations that not only require negotiation and mediation skills but notably the search for solutions in which cultural conflicts are present (Blasco 2009).

A lack of intercultural competence in a person involved in a contact with another culture produces what is called culture shock, and, specifically in the post-war period, the existence of emotional and physical disorders that impair normal activities was clinically proven (Adair et al. 2001; Earley and Peterson 2004; Randolph 2011). In the particular case of the administrator, it is desirable that their training contemplates that competence (Brasil 2002, 2004, 2010; Mintzberg and Gosling 2002; Mintzberg 2005).

In this context, in the period after the Second World War, the concern to prepare people to work in adverse cultural contexts of their origin became relevant to international trade integration and the research on this demand for training advanced to the conception of learning artefacts (Betancourt 2003; Mintzberg and Gosling 2002; Yamazaki 2005).

In the medical field, understanding the sociocultural dimensions underlying values of a patient's health is considered essential for clinical care. In this area, the goal of intercultural learning programmes is to prepare students to care for patients from diverse social and cultural backgrounds and to recognize and deal appropriately with racial prejudice and cultural and gender issues in the provision of health care (Betancourt 2003).

In administration, the need to recognize and deal with intercultural differences goes beyond the manner in which they lead their subordinates. The need to manage conflicts and differences in negotiations with their superiors, peers, customers and partners is also important. Administrators must understand and harness these differences to get the best results. The diversity management competencies (DMC) have become a necessity. Management students are subjected to didactic strategies for their development in this competency. Essentially, these strategies are content centric, through courses on diversity, and in touch through intergroup relationships. The expected outcomes of these approaches are less intergroup conflict, more cohesion, improved effectiveness of management and organizational development. The development of competence to intercultural management is based on an artefact that uses structured strategies: conceptualization (reading, lectures, films, role playing), experimentation (role playing, simulations, guest speakers), experience (immersion experience), reflection (journals), applied science (team projects), action learning (service learning), community and practice (jigsaw assignments) and action science (dialogue, case studies) (Avery and Joseph 2004).

This artefact of competence development is complemented with the Experiential Artefact of Intercultural Learning (Yamazaki and Kayes 2004) that is based on the experiential learning theory (ELT) (Kolb 1984), to outline a taxonomy of skills and competences necessary for intercultural learning. Starting from 73 known skills, Yamazaki and Kayes (2004) proposed a set of seven clusters of core competencies (based on ELT) and two additional ones underlying this research. The justification that interpersonal competences are often singled out as success indicators suggests that intercultural experiential learning, comprising cultivating human relations, is more important than abstract knowledge (Yamazaki and Kayes 2004).

This theoretical artefact comprises all the needed constructs to propose an artefact to produce an apparatus to be used with a simulator. This research used a business game as support for intercultural learning. However, despite business games having been in use for over 60 years to develop administrator's competencies, there is no research or implementation of an artefact of intercultural management components. Existing games are almost entirely aimed at learning administrative techniques or negotiation. The gap is precisely in the fact that there are no samples nor research on learning intercultural competencies using simulated business in gaming environments (e.g. business games). The objective of this research is *to verify the effectiveness of the Experiential Artefact of Cross-Cultural Learning in business games*.

2 Capacitation of Administrators

The training any manager must seek, among several competences identified, is the development of communication and expression consistent with professional practice, including the processes of negotiation and interpersonal or intergroup communications (Brasil 2002). In Brazil, all management courses need to present educational projects to the Ministry of Education and Culture (MEC), in which is imperative that must occur integration of theory and practice (Brasil 2004). The practical experience gained during the college is a common recommendation among researchers on how to place the training of professionals, not limited to the recommendations of the MEC. It is also recommended training should include competences related to the globalized world, which presupposes that relations with different cultures should be part of the curriculum. This combination of experiences and recommendations depends not only on the acquisition of theoretical knowledge. It is therefore justifiable that training should include administrator experiments and experiences as close to reality as possible, especially with regard to communication with different cultures (Corbett 2005; Friga et al. 2003; Kayes 2002; Mintzberg and Gosling 2002; Yamazaki and Kayes 2004).

The simulators are an opportunity to experience the knowledge and practices required in a controlled and safe situation. In administration, beyond the specific content simulators limited to particular issues, a type of simulator is the business game that offers the chance to experience a structured context that goes beyond the systemic view of the organization, requiring the application of complementary skills that build competences and attitudes (Corbett 2005; Klabbers 2009; Ruben 1999; Wildman 2009).

Among the various forms of connection between theory and practice, the use of business games is constant in most management courses best evaluated by MEC in Brazil (Titton 2011). The simulations and business games are an effective way to solve this need well because of the commitment and experience that they provide in training for these competences. In considering that the professional is among entrepreneurs and immersed in a globalized business environment, it is desirable that these competences include intercultural aspects (Giacalone 2004; Van Dyne 2009; Yamazaki and Kayes 2004).

As already stated, business games can be one of the ways in which the connection between theory and practice occurs during the training of administration. Business games provide activities in which students work on a simulator, competing in teams for better performance of their virtual businesses. This activity is essentially experiential. Participants make decisions in their companies by typing them into a computer system that processes the inputs of all teams and produces results. From these results, the teams perform analysis of their company data and make new decisions, and the cycle repeats again until the teacher interrupts the process and makes a final session to evaluate the results (Klabbers 2009).

The business game is a didactic apparatus with components that are the combination of a simulator with competitive features. These competitive features justify the term "game", once the dispute is the motivating feature for this activity. It should be emphasized that the playful aspect of business games ends up at this point. All the rest of the activity consists of procedures and workings relevant to the field of administration. Often the company is simulated in its entirety (total enterprise simulation) or in a specific function (marketing, finance, operations, etc.), named functional simulation. Additionally, there are games for specific purposes to simulate trading, but, in these cases, administrative techniques are really not simulated, because the focus is on the negotiation itself. In other fields of knowledge, the games are on subjects where conflict is part of the game, for example, in military war games (Klabbers 2009; Lane et al. 2007; Self et al. 1999).

In business games, the scenario consists of companies, market products and many other elements that are necessary to bring it to the simulated reality. Therefore, these business games are the representation of reality from the point of view of their creator, and there are no two identical artefacts. It is possible to compare artefacts to assess the existence of plagiarism, including legal validity, from the way components interact, but it should be important to consider that they represent the same reality (Klabbers 2009).

The perception that simulators can bring up issues related to culture has been known since the early days of using this apparatus as a teaching tool. The cultural aspect that best presents the research has reference to ethics. In the medical field, the use of simulators is justified for ethical reasons, and also its use is subject to reflections on the ethics involved in forms of treatment that may not be culturally acceptable to be ethical (Dong et al. 2010; Reznek et al. 2002; Ziv et al. 2006).

In the field of administration, the ethics of professional training is discussed in how participants act in the simulation activity. It is expected that by this experiential activity, their character is built to become an ethical professional (Brasil 2010).

This activity is performed in the form of games, which are a fundamental part of everyday culture (Stanley and Latimer 2011). In this experience, all the values, beliefs and attitudes relevant to the culture of the students present themselves as cultural aspects and serve as an opportunity for the development of interpersonal, intergroup and intercultural desired competences (Brasil 2002, 2010; Haro and Turgut 2012; Mintzberg and Gosling 2002).

3 Management Education Based on Simulations in a Cross-Cultural Context

The use of devices to support teaching in education is old; it can be said that the search for new technologies for learning is part of the teacher's own activity. For example, there are reports of the use of mannequins in medical education since the sixteenth century, extending to the incorporation of new technological facilities to approximate the maximum simulation to reality. The mannequins developed for the teaching of medicine have always been targeted for training in specific skills, with little or no utility in other didactic applications (Cooper and Taqueti 2008).

Alternatively, in management education, the development of simulators began in the early twentieth century, with a specific focus on economic systems. Angell developed a simulation game in which participants were presented in a playful way, the simulator in which the context was the capitalist economic system. This simulator was operated using cards, and it was used in several schools and colleges in the USA and England (Angell 1928).

The teaching of medicine and management benefited from the advent of computer technology between 1950 and 1960. The simulations started to use this technology to easily bring more realism since the artefacts became more complex simulators and, therefore, offered greater realism. In medicine, simulators were produced to represent the human body for the practice of technical manoeuvres. The first mannequin using computer processing was the result of a 3-year project funded by the Ministry of Education of the USA in the 1960s. The Simulator One

(SimOne) was the forerunner in the use of computers in medical simulators (Cooper and Taqueti 2008).

In the area of administration, the technological development of business games originated in the military field. In 1950, the RAND Corporation produced simulators for teaching military logistics management and air force bases. The American Management Association later introduced the first business simulator with computational processing. Within the RAND Corporation, various Nobel Prize winning scientists have participated in the design of many artefacts, including economists and the founders of game theory, and probably participated directly or indirectly in the first business simulators (Gainen et al. 1958).

Thereafter, the development of simulators happened in different directions in the two fields of knowledge. In the medical field, these devices were designed to the training of specific medical procedures, with each focusing on a set of symptoms and compatible procedures (Cooper and Taqueti 2008). In administration, the specialization in administrative functions occurred, and the advantages of computing spread simulators in many universities as a teaching tool (Keys and Biggs 1990). Since the beginning of the use of simulators, issues related to cultural aspects were emphasized. However, it should be noted that motivation for this approach occurred differently between medicine and management. In medicine, the first use of mannequins in the seventeenth century was for teaching obstetrics, under the justification that students were not yet qualified doctors and it would not be morally supportable for them to train on actual patients. All simulators up to today are accompanied by the explanation that the teaching and assessment of skills involve the same ethical issues as being performed on real patients (Cooper and Taqueti 2008). There is an obligation to provide the best treatment, ensuring safety and welfare, and the educational context may be questionable in some situations – patients are not objects to be used for the convenience of training courses (Ziv et al. 2006). This point of view is grounded in cultural values of respect for the person, which does not necessarily extend to any culture – there are numerous examples of experimental medical practices involving human beings, even in Western cultures. As an example, in the 1940s and 1950s, military personnel were subjected to radiation due to atomic explosions in the USA and then being the subject of studies on the physiological effects of this exposure (Morina 1983).

In the administration field, the relevance of intercultural issues originated in the economy after the Second World War, when soldiers were deployed to the defeated countries and later were accompanied by civilians to rebuild local economies. These people were displaced for culture different to that of their origin, and culture shock promoted physical and emotional disturbances that impaired functional performance (Oberg 2006). These disorders are known cultural shocks. This also happens in student exchanges between different cultures (Searle and Ward 1990). Thus, preparation for contact with another culture can be made for the displacement, using the following artefacts of specific training (Searle and Ward 1990), or direct contact with work that is not necessarily physically face-to-face. In this second possibility, globalization and technological facilities created sufficient conditions for functional performance to occur with intercultural contact, which will require competences consistent enough to avoid culture shock, and to get better functional performance (Avery and Joseph 2004; Earley and Peterson 2004; Mintzberg and Gosling 2002; Van Dyne 2009).

The didactic artefact for the acquisition of intercultural competences in addition to theoretical training includes several activities to a greater or lesser degree of immersion experiences and trials (Avery and Joseph 2004). However, the structure of experiential teaching strategies should occur based on an artefact of experiential learning intercultural specifically developed for this need (Yamazaki and Kayes 2004), which is presented in the next section.

4 Experiential Artefact of Cross-Cultural Learning

The way managers learn from experiences has been reviewed by Yamazaki and Kayes (2004) from the experiential learning theory of Kolb (1984) with a focus on intercultural competence. It is considered that intercultural competence, as well as interpersonal, is a dynamic process that is learned by the student. It consists of the ability to learn and adapt; therefore, it is named intercultural learning. This ability remains after the experimentation that produced the learning. In other words, the students learn how to learn on intercultural issues.

Table 1 presents the competences and skills for intercultural adaptation in structured groups of intercultural learning. Its origin is the consolidation of decades of research focusing on the identification of competencies related to success in international business, including expatriates in multinational corporations, adult workers assigned to foreign countries and young executives in business schools who experience abroad. Note that in this table, the term “host culture” is used to indicate the culture which corresponds to that which is not the same as the source actor, if the expatriate. In web environments, in which the professional acts in direct contact with another distinct culture, both are in direct contact with the different cultures. Nine intercultural competency clusters are grouped into five dimensions of competence learning, and the first four are originals of experiential learning theory (Kolb 1984) and the fifth is due to the Experiential Artefact of Cross-Cultural Learning (Yamazaki and Kayes 2004). It is important to emphasize that the procedures to form clusters that support these dimensions were produced from 73 different competencies, skills and attitudes related to intercultural learning (Fig. 1).

The potential of this research is to operationalize the preparation of administrator’s intercultural competences. Being an experiential approach, it offers the potential for the student to try the theory learned in practice available in the virtual environment. Furthermore, being an experiment in which participants from different cultures act in a business game, competing for the best performances of their simulated companies, exposure to cultural aspects can meet the desired goal.

Table 1 Competencies for successful expatriate adaptation

Learning skill dimension	Cross-cultural competency cluster	Behavioural indicator	Knowledge or skill required	Communication ability
(1) Interpersonal	(1) Building relationships	Interacts with others regularly, particularly members of the host culture	Ability to gain access to and maintain relationships with members of host culture	Recognizes and deals effectively with misunderstandings; a willingness to maintain contact with people even when communication is difficult
	(2) Valuing people of different cultures	Expresses interest and respect for host culture, including its history, customs, beliefs and politics	Empathy for difference; sensitivity to diversity	Initiates and engages in open conversation with friends and colleagues about host culture
(2) Information	(3) Listening and observation	Spends time observing, reading about and studying host culture, particularly with locals	Knows cultural history and reasons for certain cultural actions and customs	Ask questions, when possible, takes careful account of situations before taking action
	(4) Coping with ambiguity	Maintains work habits in the face of unexpected events, new experiences or unfamiliar situations	Recognizes and interprets implicit behaviour, especially non-verbal cues	Changes communication in response to non-verbal cues from others
(3) Analytic	(5) Translating complex information	Translates personal thoughts into language of host culture	Knowledge of local language, symbols or other forms of verbal language and written language	Demonstrates fluency in language of host country
(4) Action	(6) Taking action and initiative	Takes action when appropriate, even when outcome is uncertain	Understands intended and potentially unintended consequences of actions	Easily approaches and interacts with strangers
	(7) Managing others	Takes responsibility for accomplishing	Ability to manage details of a job including	Communicates implication of individual

(continued)

Table 1 (continued)

Learning skill dimension	Cross-cultural competency cluster	Behavioural indicator	Knowledge or skill required	Communication ability
		tasks related to the organizational goals	maintaining cohesion in a group	actions to others in the organizations
(5) Adaptive	(8) Adaptability and flexibility	Demonstrates acceptance of change, setbacks and challenges	Views change from multiple perspectives	Can explain perspectives on a single issue
	(9) Managing stress	Maintains work habits during times of personal and environmental crisis or in the face of heavy emotional demands	Understands own and other's mood, emotions and personality	Expresses personal feelings in an appropriate and nonthreatening way

5 Expected Results

This research makes a significant contribution to the experiential learning techniques for producing an apparatus that operates in the dynamic between the theoretical content and practical learning experienced. This is because the apparatus provides pointers to deficiencies in the learning process indicating the need for timely action. It is a breakthrough in experiential learning because it proposes a solution on a technological apparatus. The potential of this apparatus may be extended to other applications where a student is required to reflect on how theory and practice are connected, resulting in tacit knowledge that consolidates their preparation for professional life.

Strategies for the development of intercultural competence for administrators include a wide range of options: lecture, readings, films, role playing, simulations, guest speakers, immersion experience, journals, team projects, service learning, jigsaw assignments, dialogue and case studies (Avery and Joseph 2004). This research adds a new tool conducted by the reflective teacher, to enable an indicator of specific deficiencies; the intercultural dimension can receive a formative action immediately. It is a formative approach with great potential to promote learning from the recognition of disability in a reflexive action, with great didactic value.

Considering the need to train managers to be able to act locally or be immersed in an unfamiliar culture in a globalized economy, effective professional training must include intercultural competence. This module should be considered as an attachable module to 'business games' and retrieve the relevant general concept that it is a simulation game in which the 'subject' is the company. However, training for intercultural skills is not restricted to the administration area, and this module is not limited to simulators with that theme. Therefore, it can be expected that this module is attachable to any other ‘simulation game’ and thus can be used in any other area as in medicine, another known large area of knowledge that has been using simulators for the last three centuries for teaching and learning. This generalizable ability of an apparatus resulting from applied research is an expected result that ensures a characteristic of science to an application resulting from the previous knowledge from earlier research.

This module, in addition to managing intercultural learning, produces a database about how each culture learns, how each instructional procedure adopted by the teacher produced results, how each individual responded to stimuli received and so many other aspects as possible to be investigated by science. It is expected that the article produced at the end of this work will provide the scientific community with more than the simple apparatus, but a methodology for implementing this technique as a result of decades of research so that new devices are produced with better solutions than adopted in the methodological procedures used.

6 Procedures

The first test of any system mainly provides information about its operational aspects. However, in this case the focus is also on the power to detect cross-cultural issues. We found weaknesses as well as strength aspects in the system.

The system consisted of a business simulation game (Titton 2015) and the apparatus running together in the cloud system accessed through web and smart devices by xxx students from yyy school classes from three different business schools in two countries. Since the main idea was to test the system, each professor in each class received a different set of instructions about the use of the whole system as shown in Table 2. The total of 231 students used the system, and no personal data remained in any database. The only control that identified each student was used only not to let one to answer twice the survey and was deleted after each round was processed and the business game was activated again.

It was considered to be risky to give a feedback from a software in this development phase, so professors received no feedback from the system at this phase. Since this was a system test, it was considered that the presence physically and by distance of few foreign students was not a problem.

Results about the system operation – We analysed the data from observations taken in class and from the system. We first looked at all activities made in class III. There, we were the professors. In classes I and II, we stayed in some classes only as observers. In class IV we looked only data from the system because it was in another school distant from our city. In class III, after the first decision time, the system access was turned off to the round processing, and the apparatus assumed the interface as previewed. This procedure was done in class, and students should answer the survey within 15 min.

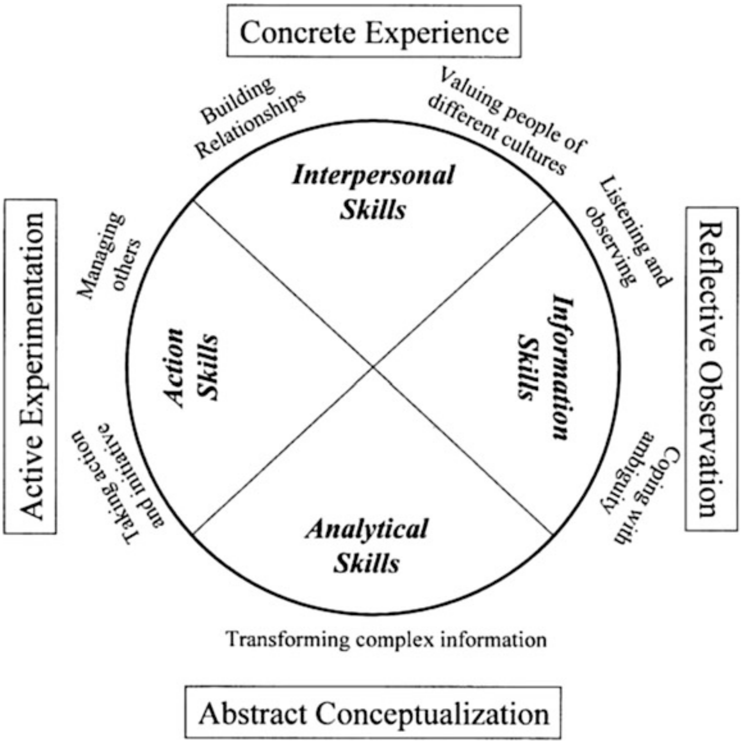

Fig. 1 Experiential Artefact of Cross-Cultural Learning Skills (Source: Yamazaki and Kayes (2004, p.371))

The first detected problem was that one student arrived late and complained that has not answered the survey. This was the first sign that the original idea to activate the apparatus while the system was under processing should not be a good solution. For this reason, at the second round, the same questions were presented to give everybody the chance to answer the same questions. The same problem was reported by the professor in class IV, but no complain about this came from professors in classes II and III.

The operational solution to be implemented in the system to solve the first problem is a flow change. Instead of blocking the system to activate the apparatus, from now on the apparatus will be activated by the game at the first time the student logs in the game after the processing. Along the test, the activation of the apparatus happened while the system was under processing. From now on, the processing will log out all users until the processing happens. After this, the first log-in for each user will activate the apparatus even whether the processing has finished or not.

The second detected problem was about the navigator. The standard in all classes is Chrome®, and the detected problem was that after one student answers the survey, the next to use the same computer and answer the survey received the message that the survey is complete. This problem happens because teams take decisions using one computer even when there is a computer for each student in the class. Anyway, the apparatus was changed to clean the buffer memory when a student logs out the system.

However, this problem may be students cheating participation. What was found in class III was that some students really did not access the computer. That could be a concrete collaborative team where one works in the computer while all really discuss the analysis and the decisions. However, we observed that both cases happen in class.

The survey was presented starting on round 2 and was applied two times in each class. However, the system showed the questions in other rounds since the access to the system was closed while processing. This resulted in the spontaneous generation of answers from part of the students. This feature will be corrected in such a way that the professor will be able to choose whether to activate the apparatus survey at each round.

All other features worked as expected in the special language selection. The simulation game runs in English and Portuguese by student selection. The apparatus was able to detect the language selected in the simulation game, and all questions were presented in the student language.

Results about cross-cultural data – The other analysed aspect is the power to detect cross-cultural issues. The internal process of the apparatus considers data from a survey. The questions on this survey change at each round in such a way that nine cross-cultural competence clusters (Table 1) can be covered as questions go changing.

The log files from the apparatus were analysed without any action from the professors. The presence of only 5 % of foreign students, including the visiting ones, demanded some attention from the professors. However, the objective of the disciplines was not to drive cross-cultural issues. Furthermore, the main idea was not to expose the apparatus indicators as it was under test.

The questions measured the first four clusters: interpersonal, analytic, action and information. The system analyses each team looking for a standard for each team instead of working with the whole data in any statistical model. This method empowers the analysis as it considers that each team has a unique history. Each team has four positions occupied by three or four students grouped in 55 teams.

Parallel to analysing data from the system, we extracted facts from contacts with professors and students not only in class but also out of the class. Besides the mentioned notes (Table 3), we noted the following:

- Teams with cross-cultural problems pointed by the apparatus more than one round presented low rankings.
- On the other hand, teams with cross-cultural problems for only one round presented high rankings.
- Spontaneous answers to the survey quite always showed low severe problems with no consistency from one round to the next. Maybe an effort to say that something was not going well, but the right question was not there.

Table 2 Students in the test

Class Id/location/ time of the class	Students	Procedures adopted by each professor
I. Brazil 1/morning – once a week	1st year course/Management/foreign students. Total 72 students	Answering was not mandatory. When processing the simulation game, students had no access to the system. Students could answer a survey shown by the apparatus inside the game at this time. This happened from the previous date of the class until the start of the class. Professor processed the system the day before to have time to analyse the results
II. Brazil 1/night – once a week	1st year course/Management/foreign students. Total 64 students	Answering was not mandatory. When processing the simulation game, students had no access to the system. Students could answer a survey shown by the apparatus inside the game at this time. This happened from the previous date of the class until the start of the class. Professor processed the system the day before to have time to analyse the results
III. C/Brazil 1/morning – twice a week	3rd year course/Accounting/foreign students in class and also others in Poland. Total 59 students	Answer was mandatory twice. Classes happened on Thursday and Friday mornings. For this reason, students could answer twice a week the survey in the apparatus. The apparatus activated automatically when the system was under processing. In every class, there were two professors observing each team in detail about difficulties and how the decision process happened
IV. Brazil 2/night – once a week	1st year course/Management/no foreign students. Total 36 students	Answer was mandatory twice. The professor instructed students to answer a survey that was active while the system was processing at the end of each class

- In the team where two students from Brazil and two from Poland were together, there were problems with time. The difference of time was making their job difficult.
- In one team where a visiting foreign student was together with Brazilians, the language was a concrete problem. In this case, the foreign student used the system to talk to others because of the English version of the system. With such difficulties, they worked well in a functional virtual company, as said by one of them.

Table 3 Analysis of the power of the apparatus to detect cross-cultural issues

Cross-cultural competence clusters used	Cross-cultural difficulties detected in teams	Analysis
Building relationships	Spontaneous answers showed problems (class I/1 team) in three rounds	The team 5 at class III showed 2 of 4 students pointing problems in this cluster at the second round. All teams of class III showed the same problems at round 5
	Mandatory answers showed problems (class III/2 teams)	In class III (15 teams), 13 teams got their lower rankings at round 5, the other 2 teams got their lower ranking at the previous round
Listening and observation	Spontaneous answers showed problems (classes I/1 team and II) in different rounds	The team 5 at class III showed 3 of 4 students pointing problems in this cluster at the second round. The other teams in the same class pointed problems at round 5 only
	Mandatory answers showed problems (class III/1 team)	
Translating complex information	Spontaneous answers showed problems (classes I/1 team and III)	Cross-cultural issues graduation was not severe
	Mandatory answers showed problems (class III/2 teams)	
Taking action and initiative	Spontaneous answers showed problems (class I/1 team)	Team 2 at class III showed not severe problems at this cluster. This team got a continuous low ranking in all rounds
	Mandatory answers showed problems (class III/2 teams)	

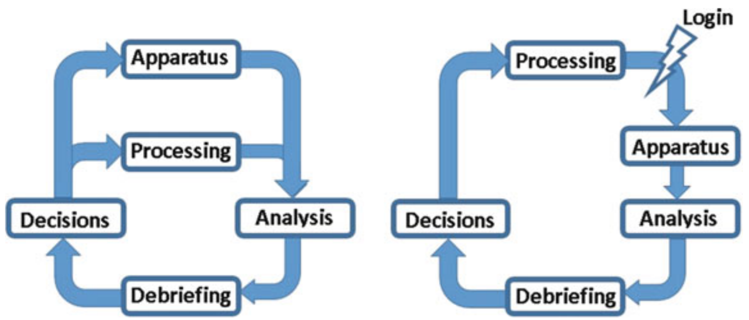

Fig. 2 Change in the flow

- The presence of the professor close to students as they discuss seems natural to students, as they showed to us. From this proximity, it was possible to confirm that the teams with problems shown by the apparatus are the same where discussions were hot compared to the whole class, as well as the teams where only one or two students were present.

At the final rounds, we questioned if the apparatus was really working well to catch the effective answers or if the capture of information using paper could work as well. We passed a paper survey with the next group of questions. Class III showed that 60 % of the students presented problems on coping with ambiguity (cluster 4). No severe problems were identified in other clusters. The same teams with problems, especially severe ones, showed the same issues in the paper survey, however, with less severity.

7 Conclusion

The technical issues showed the need to change the process and part of the apparatus as consequence. It worked well for a first use but needs a new test with the solutions adopted from this first test.

The power of detection is before any use of the apparatus to suggest anything to a professor. From this test we can conclude that the system can detect cross-cultural issues and identify the kind of it. Compared to the paper survey, it showed higher level of accuracy but a lower capacity in terms of covering the whole students because of the need to the change shown in Fig. 2. This change may be enough to cover all students.

The limitation of the test to the current research was that quite all students are from the same country. However, in the classes there are students from distant parts of Brazil with some cultural differences justified by the way each local culture received previous people and foreign immigrants. There is no doubt that the cultural distance is not enough to justify to call different cultures, but it explains the cross-cultural problems detected.

Furthermore, it was shown that what promotes difficulties is not related to how good is the team performance in the simulation. It was not expected that this would be found as the data showed.

The apparatus needs more testing, and the professors and scientific community are invited to join this research. The test will restart with a new configuration.

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References

Adair, W. L., Okumura, T., & Brett, J. M. (2001). Negotiation behavior when cultures collide: The United States and Japan. *Journal of Applied Psychology, 86*(3), 371–385.

Angell, N. (1928). *The money game* (1st ed.). London: J.M.Dent, Sons.

Avery, D. R., & Joseph, S. (2004). Blending content and contact : The roles of diversity curriculum and campus heterogeneity in fostering diversity management competency. *Academy of Management Learning & Education, 3*(4), 380–396.

Betancourt, J. R. (2003). Cross-cultural medical education: Conceptual approaches and frameworks for evaluation. *Academic Medicine: Journal of the Association of American Medical Colleges, 78*(6), 560–569.

Blasco, M. (2009). Cultural pragmatists? Student perspectives on learning culture at a business school. *Academy of Management Learning & Education, 8*(2), 174–187.

Brasil. (2002). Parecer CES/CNE 0146/2002, Ministério da Educação, Conselho Nacional de Educação, Câmara de Educação Superior.

Brasil. (2004). Resolução 1/2004, Conselho Nacional de Educação, Câmara de Educação Superior.

Brasil. (2010). Resolução Normativa CFA 393, Conselho Federal de AdministraçãoBrasília, Brasil.

Cooper, J. B., & Taqueti, V. R. (2008). A brief history of the development of mannequin simulators for clinical education and training. *Postgraduate Medical Journal, 84*(997), 563–570.

Corbett, A. (2005). Experiential learning within the process of opportunity identification and exploitation. *Entrepreneurship Theory and Practice, 29*, 473–491.

Dong, Y., et al. (2010). Simulation-based objective assessment discerns clinical proficiency in central line placement a construct validation. *CHEST, 137*(5), 1050–1056.

Earley, P. C., & Peterson, R. S. (2004). The elusive cultural Chameleon: Cultural intelligence as a new approach to intercultural training for the global manager. *Academy of Management Learning & Education, 3*(1), 100–115.

Friga, P. N., Bettis, R. A., & Sullivan, R. S. (2003). Changes in graduate management education and new business school strategies for the 21st century. *Academy of Management Learning & Education, 2*(3), 233–249.

Gainen, L., Levine, R. A., & Mcglothlin, W. H. (1958). *BASELOGS – A base logistics management game* (The Rand Corporation, U.S. Air Force – Project Rand). Santa Monica.

Giacalone, R. A. (2004). Education for the 21 st century*, Academy of Management Learning & Education, 3*(4), 415–420.

Gosen, J., & Washbush, J. (2004). A review of scholarship on assessing experiential learning effectiveness. *Simulation & Gaming, 35*(2), 270–293.

Haro, S. P., & Turgut, G. (2012). Expanded strategy simulations: Developing better managers. *Journal of Management Development, 31*(3), 209–220.

Issenberg, S. B., et al. (2005). Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review. *Medical Teacher, 27*(1), 10–28.

Kayes, D. C. (2002). Experiential learning and its critics: Preserving the role of experience in management learning and education. *Academy of Management Learning & Education, 1*(2), 137–149.

Keys, J. B., & Biggs, W. D. (1990). A review of business games. In J. Gentry (Ed.), *Guide to business gaming and experiential learning, Association for Business Simulation and Experiential Learning (ABSEL), East Brunswick/Kogan Page*. London: Nichols/GP Publishing.

Klabbers, J.H.G. (2009). *The magic circle : Principles of gaming & simulation – artefacting and simulation for learning and instruction*. 3rd. ed. [s.l.], Rotterdam, The Netherlands: Sense Publishers.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. *Journal of Organizational Behavior, 8*(1984), 19–38.

Lane, H. C. et al. (2007). *Intelligent tutoring for interpersonal and intercultural skills*. Interservice/Industry training, simulation, and education conference 2007. Anais...

Mintzberg, H. (2005). The magic number seven—plus or minus a couple of managers. *Academy of Management Learning & Education, 4*(2), 244–247.

Mintzberg, H., & Gosling, J. (2002). Educating managers beyond borders. *Academy of Management Learning & Education, 1*(1), 64–76.

Morgan, P. J., et al. (2002). Simulation technology – a comparison of experiential and visual learning for undergraduate medical students. *Anesthesiology, 96*(1), 10–16.

Morina, J. T. (1983). Denial of atomic Veterans' Tort Claims: The enduring fallout from Feres v. United States. *William and Mary Law Review, 24*(2), 259–293.

Oberg, K. (2006). Cultural shock: Adjustment to new cultural environments (reprint). *Practical Anthropology, 29*, 142–146.

Randolph, W. A. (2011). Developing global business capabilities in MBA students. *Journal of Management Inquiry, 20*(3), 223–240.

Reznek, M., Harter, P., & Krummel, T. (2002). Virtual reality and simulation: Training the future emergency physician. *Academic Emergency Medicine, 9*(1), 78–87.

Ruben, B. D. (1999). Simulations, games, and experience-based learning: The quest for a new paradigm for teaching and learning. *Simulation & Gaming, 30*(4), 498–505.

Satava, R. M. (2008). Historical review of surgical simulation – a personal perspective. *World Journal of Surgery, 32*(2), 141–148.

Searle, W., & Ward, C. (1990). The prediction of psychological and sociocultural adjustment during cross-cultural transitions. *International Journal of Intercultural Relations, 14*(4), 449–464.

Self, J. et al. (1999). The defining characteristics of intelligent tutoring systems research : ITSs care, precisely. *International Journal of Artificial Intelligence in Education*, *10*, 350–364.

Sims, R. R. (1978). Kolb's experiential learning theory: A framework for assessing person-job interaction. *Academy of Management Review, 8*(3), 501–508.

Stanley, D., & Latimer, K. (2011). "The Ward": A simulation game for nursing students. *Nurse Education in Practice, 11*(1), 20–25.

Su, S. Y. W., Lee, G., Lampotang, S. (2005). Learning object and dynamic e-learning service technologies for simulationbased medical instruction. In M. Dean, Y. Guo, W. Jun, R. Kaschek, S. Krishnaswamy, Z. Panand, Q. Z. Sheng (Ed.), Web information systems engineering – wise 2005 workshops, Proceedings. Anais ... Heidelberger Platz 3, D- 14197 Berlin, Germany: Springer-Verlag Berlin.

Titton, L. A. (2011). *Arquitetura para orientar a seleção de JSE por IES: contribuição para o ensino de logística*. [s.l.] Universidade de São Paulo.

Titton, L. A. (2015). *Meban general business simulation*. http://www.jogos-deempresas.com.br. 1 Mar 2015.

Toegel, G., & Conger, J. A. (2003). 360-degree assessment: Time for reinvention. *Academy of Management Learning & Education, 2*(3), 297–311.

Van Dyne, L. (2009). From experience to experiential learning: Cultural intelligence as a learning capability for global leader development. *Academy of Management Learning & Education, 8* (4), 511–526.

Wildman, J. L. (2009). Using simulation-based training to enhance. *Academy of Management Learning & Education, 8*(4), 559–573.

Yamazaki, Y. (2005). Learning styles and typologies of cultural differences: A theoretical and empirical comparison. *International Journal of Intercultural Relations, 29*(5), 521–548.

Yamazaki, Y., & Kayes, D. C. (2004). An experiential approach to cross-cultural learning : A review and integration of competencies for successful International University of Japan. *American Management Learning & Education, 3*(4), 362–379.

Ziv, A., et al. (2006). Simulation-based medical education: An ethical imperative. *Simulation in Healthcare: Journal of the Society for Simulation in Healthcare, 1*(4), 252–256.

Part IV
Policy and Planning Fields

Urban Planning Games and Simulations: From Board Games to Artificial Environments

Ric Stephens

Abstract Urban planning games and simulations span more than a century of public and professional interest. Although they are primarily recreational in nature, there is potential for them to be catalysts to educate the public on environmental, economic, and social issues connected with urban sustainability, resiliency, and regeneration. Early games were based on a linear (mechanical) approach to urbanism. Today's computer simulations have various degrees of autonomous systems interactions. As games and simulations evolve in complexity and realism, so too does their ability to mirror more integrated urban systems and explore a wide range of scenario planning alternatives. Future simulations will include more autonomous interaction and eventually artificial intelligence-designed environments.

1 Urban Planning Board Games: Around and Around We Go

1.1 The Landlord's Game, 1904

The seminal board game for urban planning was originally created to illustrate the need for social reform. The *Landlord's Game* was patented by Maryland Quaker Elizabeth "Lizzie" J. Magie in 1904 "to demonstrate the evils of accruing vast sums of wealth at the expense of others. A firebrand against the railroad, steel and oil monopolists of her time, she told a reporter in 1906, 'In a short time, I hope a very short time, men and women will discover that they are poor because Carnegie and Rockefeller, maybe, have more than they know what to do with.'" Players rolled a die to move their marker around the board. When a player lands on a space, they may purchase it if unowned or must pay a fee if owned by another player. A player wins the game by amassing the most properties and bankrupting the other players.

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As with most successive urban planning board games, movement is linear in a closed loop and the game environment is unchanging. The original game had rules for "monopolists" and "anti-monopolists." This board game was popular among many activists in New England with various published and homemade versions. Numerous games devoted to buying, selling, and developing land followed over the next three decades.

The Landlord's Game was reformatted in 1923 by E. M. Phillips. It included place-names and the implication that the game "circuit" was a railway. This version emphasized real estate development and railroad transportation. As with the original version, "jail" was included as a penalty, and winning meant accumulating property and wealth until the other players became bankrupt—in short, a zero-sum game (Figs. 1 and 2).

1.2 Monopoly, 1933

About a decade later, and immediately after the 1929 stock market crash, Charles Darrow designed a version of this game with the universally recognized name *Monopoly*. His original game, which copied many elements from a game by Charles Todd, was inked on round oil cloth (Fig. 3).

In 1935 he redesigned *Monopoly* into a square and patented it as a "board game apparatus." (Darrow 1935). Parker Bros acquired the game the same year and began mass producing 20,000 sets per *week*. The game has remained essentially in this patented form for the past 80 years (Fig. 4).

This game was one of many variations on urban development dating back to the 1910s, and not—as often portrayed—the sole creation of Charles Darrow. Parker Bros mass production and copyright protection did position this as the quintessential American board game. Among the many transformations from the original *Landlord's Game*, *Monopoly* had shifted the emphasis from critiquing socioeconomic inequality to celebrating capitalism, from anti-monopoly to "pro-monopoly." *Rich Uncle Milburn Pennybags* [later renamed *Mr. Monopoly*] was not a villainous slum lord but a happy land developer. Role playing is centered on urban development (real estate and utilities) with the objective to concentrate *all* capital—ironic, considering Ms. Magie's intent "to demonstrate the evils of accruing vast sums of wealth at the expense of others."

Professor Ralph Anspach introduced *Anti-Monopoly* in 1973 "in part as a response to the lessons taught by the mainstream game, which he believed created the impression that monopolies were something desirable. His intent was to demonstrate how harmful monopolies could be to a free-enterprise system, and how antitrust laws work to curtail them in the real world." (Wikipedia 2015) This game was immediately litigated by Parker Bros for copyright infringement. Research obtained during the lawsuit revealed that there have been numerous versions of "Monopoly" preceding the patent (Fig. 5).

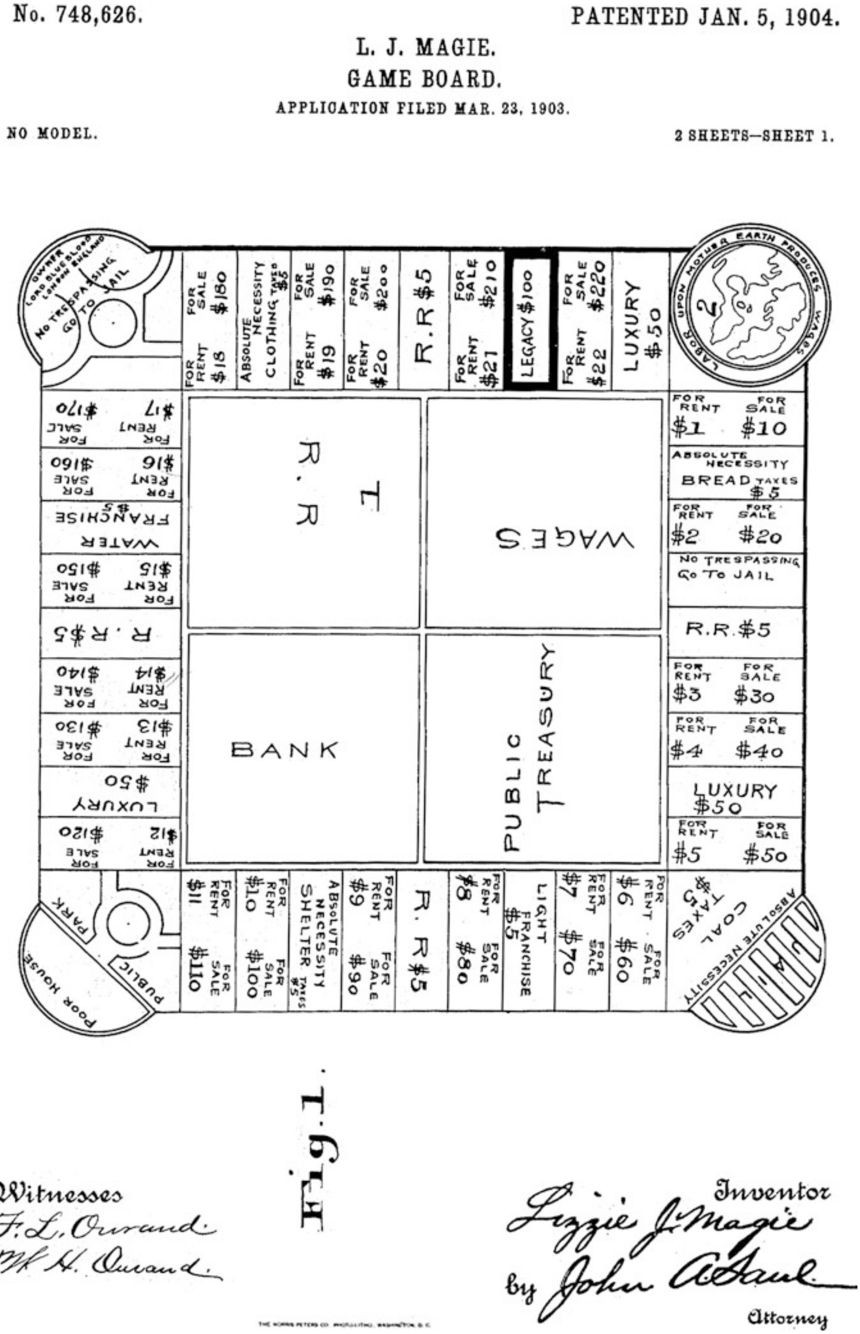

Fig. 1 Landlord's game board patent, 1904

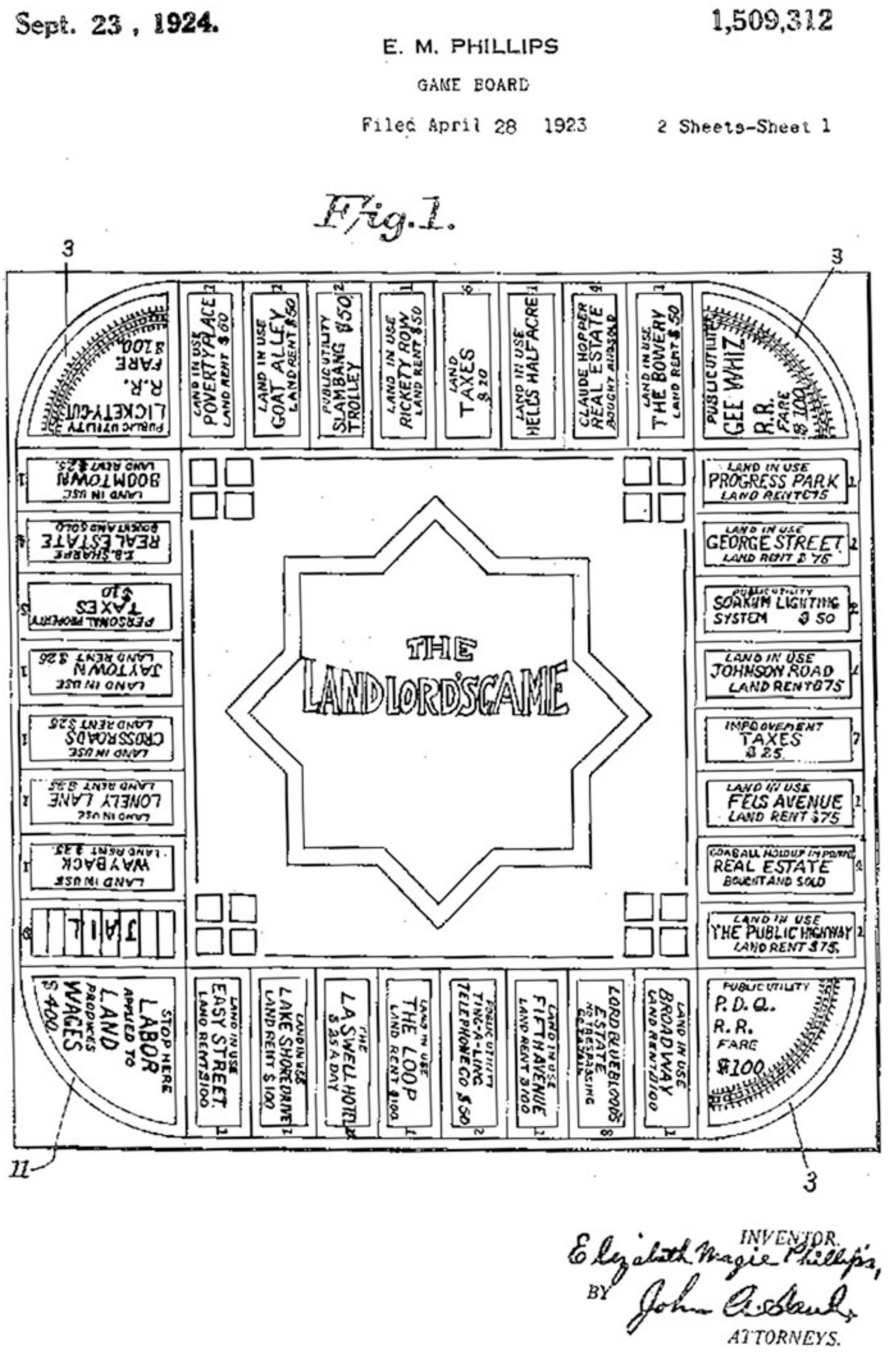

Fig. 2 The Landlord's game board patent, 1923

Fig. 3 Monopoly game cloth, 1933

1.3 Community Land Use Game (CLUG), 1972

"CLUG (Community Land Use Game) is designed to provide players with an understanding of several underlying factors affecting the growth of an urban region. It has been used with players from junior high to graduate school and also with non-students. It unites concepts from sociology, economics, and geography. Players invest in land, construct buildings of various types, and seek ways to fit their investments into the evolving local economy to make a return on investments. Players compete with each other, but also learn to cooperate with each other for some purposes. The package includes rules and strategies for players, readings which pertain to issues highlighted in the game, and an instructor's manual. A series of "experiments" modifies the basic rules of the game and allows players to explore systematically the effects of urban phenomena like municipal finance, land use

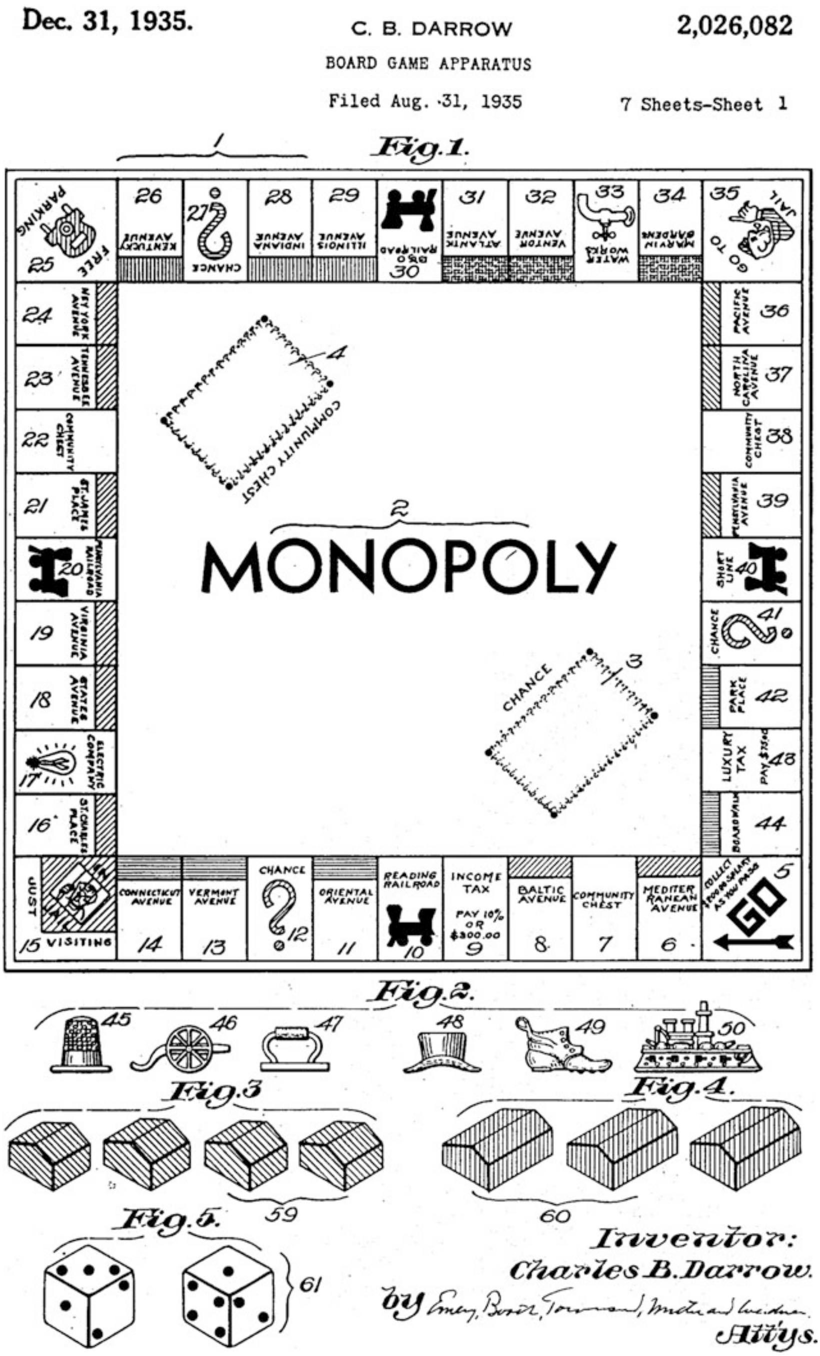

Fig. 4 Monopoly board game apparatus patent, 1935

Fig. 5 Monopoly game board, ca. 1975

regulation, and environmental pollution" (ERIC 2015). The 8th edition of CLUG was published in 2013 marking half a century of play "by thousands of students, public officials and civic groups over the past 50 years, both in this country and abroad. It has been used in over 100 universities, colleges and high schools as well as in many civic meetings" (Feldt 1972).

1.4 City Planning, 1975

One of the earliest board games devoted specifically to urban planning concepts was Forrest Wilson's *City Planning: The Games of Human Settlement* published in 1975. "City Planning presents a series of games designed to show the great number of rules for living together and how these rules determine the form of human

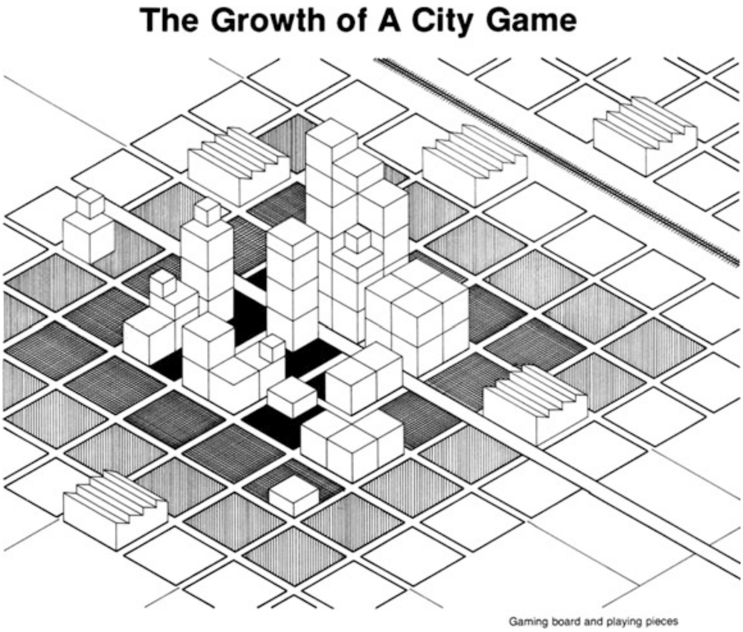

Fig. 6 City planning gaming board and playing pieces, 1975

settlements. The games are intended to explain the sets of "rules" from which communities, from simple hunting cultures to the modern city, develop, and to provide a method of teaching the basics of *City Planning*" (Wilson 1975). There are multiple games based on historic settlement typologies including *hunter-gatherer* and *industrialization* (Fig. 6).

1.5 Big City, 1999

In 1999, *Big City*, by Franz Vohlwinkel, further develops urban planning concepts with more detailed urban planning and design elements. "This game, with its really wonderful plastic bits, is about building a city. Players acquire cards in eight different 'neighborhoods' and then use them to lay out buildings either one, two, or three spaces large. The points they receive for a given building is a base score plus bonuses for the buildings surrounding it. What makes this game really unique is the city hall. Some player must play it (scoring no points for himself) in order for anyone to start placing any structure beyond the simple residences and business" (BoardGameGeek 2015). The rules to the game encourage new urbanist planning principles and player collaboration. There is a Lego version of *Big City* which enables even more creative city modeling (Fig. 7).

Fig. 7 Big city game pieces, 1999

1.6 Urban Village, 2007

Urban Village is your chance to figure out [urban planning]. One observer calls Schudlich's game "Jane Jacobs meets Sim City." It is an opportunity to develop a hybrid Detroit community, based on the less-than-perfect socioeconomic conditions provided. Fred Goodman, a University of Michigan Professor of Education Emeritus specializing in game design, defines *Urban Village* as "a cross between pin the tail on the donkey and playing school," he says. "You're playing city planner, and you can get dizzy trying for the best fit because it's harder than you think. But this inspires you to think about the inconsistencies of your own set of assumptions, revealing your own values and biases" [excerpted from "Mack Avenue: The Game" by Rebecca Mazzei] (Stephens 2015) (Fig. 8).

1.7 Monopoly City, 2009

In the intervening years, *Monopoly* created hundreds of variations from popular culture, themes, and individual cities. In 2009, *Monopoly City* was presented as an enhanced version of the urban development concept. This new version was essentially the original format and familiar play:

Fig. 8 Urban village game pieces, 2007

> But not so fast. Everybody wants to win of course. And with the 80 extra buildings* they added to the game, nothing was ever so uncertain. On every property you can build residential or industrial buildings. The first is not protected against negative buildings (hazards) and requires positive buildings otherwise the property becomes worthless. The industrial buildings on the other hand are protected but they cost twice as much! So you will have to make choice. And the added electronic device will, besides timing deals, always indicate how many buildings you can exactly make. (BoardGameGeek 2015)

* *Monopoly City* includes new building types such as parks, power plant prisons, rubbish dumps, schools, sewage plants, water towers, and wind farms (Fig. 9).

1.8 City Tycoon, 2011

City Tycoon was a return to the real estate acquisition model of *Monopoly* with more nuance and complexity. “In *City Tycoon* players assume the role of businessmen investing their own capital in expansion of the city. Their main purpose is to increase the standard of living, and thus the happiness of its citizens. They have within reach a whole range of projects that the city council wants to achieve, but which lack the funds. By skillfully selecting plans, using available space and

Fig. 9 Monopoly city game board and playing pieces, 2009

deciding which projects their money should be spent on they will be expanding the city and competing for the title of the most people-friendly company. Game play in *City Tycoon* passes through four stages, and in each of them the buildings get larger and more impressive while at the same time requiring more resources and giving better benefits. Players quickly notice the relations between them and may choose several possible strategies to develop their investments, for example, focusing on making money, constructing scoring buildings to the exclusion of all else. Each of these strategies has its pluses and minuses, and the actions of other players might force you to expand in new directions and change your tactic" (BoardGameGeek 2015) (Fig. 10).

1.9 Urban Sprawl, 2011

In 2011, Chad Jensen introduced *Urban Sprawl* as a role-playing game parallel to *Monopoly*, but with the exception that the ultimate goal is "placemaking" and "prestige" rather than wealth.

> "*Urban Sprawl* abstractly models the growth of a town into a teeming metropolis. Players assume the roles of entrepreneur, tycoon, and politician—each helping in the development of a hypothetical 'Anywhere, USA.' Wealth and Prestige will be earned and spent throughout the game. Buildings will rise only to later be demolished for better and larger fare. Throughout the game players will gather valuable Permits. These will result in either a

Fig. 10 City tycoon game tiles, 2011

> wealthy Investment or the foundation of a new building Contract. Players will strive to become dominant in one or more building Zones in order to acquire beneficial political offices. All of this eventually leads to the end game—a vibrant metropolis that is revered around the world—when the player with the most Prestige will be crowned the winner" (BoardGameGeek 2015).

This game has been translated into numerous languages, initiated multiple forums, and adapted into several variations including "Taking on the Donald" [referring to the real estate tycoon, and presidential candidate, Donald Trump] (Fig. 11).

1.10 The City, 2011

Yet another urban development role-playing game was released in 2011: *The City*. "In *The City*, players try to quickly and skillfully build their own city over the rounds, bringing in revenue and victory points (VPs). The cards are both buildings and currency, and the first player to collect 50 victory points wins the game" (BoardGameGeek 2015). Multiple urban planning objectives are incorporated in this game. For example, an industrial park is awarded more value when it includes a research center; mixed-use development is encouraged; and public amenities are recommended (Fig. 12).

Fig. 11 Urban sprawl game board, 2011

Fig. 12 The city playing cards, 2011

1.11 City Council, 2013

The expansion of role-playing games allows for more specialized environments. In 2013, Elad Goldsteen introduced *City Council*, a board game that recreated a local government and city administration scenario.

"In *City Council* each player takes the role of a council member of a newly founded city. The government will select the members of the city council for the first few years until the city rises and flourishes, by which time the most popular member will receive the position of Mayor. In order to build the city, you and the other councilmen must maintain a low level of pollution, fight crime, create jobs, and sustain an adequate city budget. If you and the others don't keep up the good work, the city project might not succeed, the government will take over, and all players will lose. As a member of the council, you must also strive to gain the favor of the different political groups who rule the streets of your city. As the game progresses and the city grows larger, more and more political interest groups will try to impose their will on the city by knocking on your office door and asking you for small "favors" in which you will have to act on their behalf. In return, they'll offer you their support and you'll receive victory points for your personal cause, possibly allowing you to become the city's first Mayor" (BoardGameGeek 2015). The game introduces urban planning practices along with politics, ethics, and community development. [A similar game focusing on the mayor's position—*Small City*—was also released in this year.] (Fig. 13)

This is not an exhaustive list of urban planning-related board games, and more are continuously released such as the recent *City Mania*. Some self-published games such as *Little Big City* are not included, but these have elements worth further examination. Other games were excluded, such as *Monster City Planners*,

Fig. 13 City council game, 2013

which include urban planning concepts, but were combined with fantasy or science fiction. [*Cité*, *Ekopolis*, *Cityscape*, and *Monopoly Cityville* have unique perspectives on urban planning and merit additional study.] This selection illustrates the significant trends in game design. A century of board game evolution resulted in more complex games, more specific roles, and more diverse objectives. For urban planning, the games encompassed more issues connected with evolving ethics and practices such as sustainable development and urban vitality. [In addition to urban planning, a variety of board games explored transportation planning such as *Gridlock*, *City Lines*, and *Sunburst City Transport*.] Board games have also adopted more flexibility and adaptability enabling them to exceed the confines of a simple linear game path. Most games have also introduced greater degrees of randomness in events and interactions resulting in more unique game outcomes. Concurrent with board game development in the last two decades, computer games have expanded play into other dimensions with multimedia.

2 Computer Simulations: The Butterfly Effect

"There has been a shift from gaming to simulation focused on particular urban systems. Simulations and games have become simpler and as a consequence more effective. Coming decades promise wave after wave of urban gaming activity. This will be driven by the dual need of addressing increased complexity and the urgent need to establish communication in these environments" (Rizzi 2014). This shift in emphasis from games to simulations matches the increasing emphasis on experiential design. This is driven by the desire for escapist immersion and interactivity possible with increasingly complex simulations that are approaching alternative reality environments.

2.1 SimCity, 1989

The 1989 launch of *SimCity* by Will Wright was a defining moment in urban planning and design games. Until then, several board games considered elements of city planning, but the complexity of interactions and open-ended city building were not possible without sophisticated personal computer software.

> In *SimCity*, the player is given the task of founding and developing a city, while maintaining the happiness of the citizens and keeping a stable budget. In *SimCity 2000*, *SimCity 3000* and *SimCity 4*, the player is allowed to alter the terrain of the city before building on it. The player must define development zones, each having limits on the kind of development that can occur there. Development of the zones is not performed directly by the player, but happens when certain conditions are met, such as power supply, adequate transport links or acceptable tax level. The residential zones, in green, provide housing for Sims; the commercial zones, in blue, provide shops and offices; and the industrial zones, in yellow, provide factories, laboratories and farms. There are three different densities in the game:

> low density for small buildings, medium density for low to mid-sized buildings, and high density for anything up to large tower blocks (Wikipedia 2015)

An early version of *SimCity* included a city planning manual, *Dr. Wrights Urban Planning Guide*, endorsed by the *American Planning Association* (SNES 1991) (Fig. 14).

SimCity now has an open-source code version, *Micropolis*, and users are free to design the game however they wish with some restrictions. A website dedicated to “all things SimCity” provides information, networks, and news on simulation development with the following introduction: “This is a new SimCity that delivers unprecedented depth of simulation. The model-like world and detail of the simulation make this the most responsive and personal *SimCity* ever. This is also the most expansive city management game yet where you can control a region that delivers true multi-city scale and play a single city or up to 16 cities at once each with different specializations. Multiplayer is also a first for the series, which adds a new dimension to your game as your decisions impact both your city and your region and creates new ways to play by collaborating or competing to earn achievements” (SimCity 2015).

Since its inception, *SimCity* has been improving and expanding its database of simulated cities and now has versions of most global mega-cities with an impressive depth of scale powered by the *GlassBox* engine. Another unique feature is the depth of role-playing. “For the first time, create truly unique cities with different

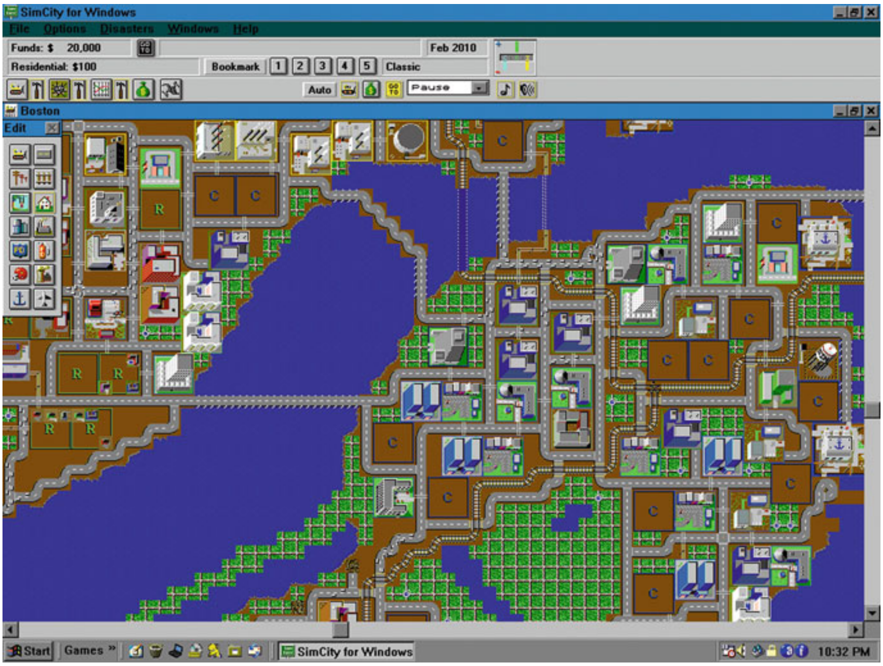

Fig. 14 SimCity screenshot, 1989

specializations. Mayors seeking intelligent Sims can build a college town full of libraries, community colleges and universities. Specialize in Big Business such as Casinos, Electronics, Coal, Trade, and more to increase the wealth of your city. Each specialization has major benefits but consequences as well. Educated Sims unlock technologies that will benefit your region, but large universities are expensive to maintain. Casinos will bring tourism and raise Simoleons [*SimCity* currency] but also attract unwanted crime" (SimCity 2015).

"From these simulations, the logic of the game goes, you can abstract urban design principles. Where our cities appear unpredictably chaotic and impossibly complex, *SimCity* harmoniously tames this uncertainty into a manageable landscape. It offers a micropolis (as it was originally titled) to serve as a model for our own. It represents our cities not as they are but as they could be: calculated, optimized, controlled" (Kofman 2015). This expresses two key elements connecting games and simulations with urban planning: education and aspiration. An informed and motivated society will be capable of sustainability, resiliency, and regeneration (Fig. 15).

2.2 *City RAIN, 2010*

An electronic board game that focuses on urban sustainability, *City RAIN* starts with an existing city that must be restructured to become more environmentally responsible. The original concept is from the Brazilian game design company Mother Gaia and was named Cidade Verde [Green City]. Ovolo Entertainment describes *City RAIN* as "an award-winning strategic urban planning puzzle game."

Fig. 15 SimCity Tokyo tower screenshot, 2015

> As a member of the Rescue And Intervention Non-profit (RAIN) organization, your job is simple. You must rescue cities on the WEPA blacklist before they are punished by the world for being destructive to our irreplaceable natural resources. Ultimately, you must help reorganize cities so that they will become environmentally friendly and inspiring places to live. But it won't be easy. You will be constantly challenged by Bane Industries, one of the last corporations in the world that refuses to submit to WEPA environmental standards for process and production. (Ovolo 2015)

City RAIN is a departure from other urban planning simulations in that it focuses on environmental conservation and sustainable development. It is somewhat simplistic in its dualistic approach, but ideal introduction to sustainability principles for younger students (Fig. 16).

2.3 Cities: Skylines, 2013

Finnish game developer *Colossal Order* designed *Cities: Skylines*, a competitive urban planning game to *SimCity* in 2009 and released it in 2013 after *SimCity* received critical review by the public. Building on their expertise with transportation simulation from *Cities in Motion*, *Colossal Order* targeted more automated mobility, larger city population size, and enhanced graphics with the *Unity* engine. "Generally critics considered *Cities: Skylines* to have superseded *SimCity* as the leading game of the genre" (Wikipedia 2015).

Fig. 16 City RAIN screenshot, 2010

Cities: Skylines allows modding and users have created thousands of assets including first-person mode and a flying simulator. "Indeed the range and depth of mods is astounding, everything from famous locations, like *GTA 5*'s [*Grand Theft Auto*'s] *Los Santos*, to first person cameras, to tweaks that improve the look of the game, to tools that change its very nature. This was always part of the plan" (Campbell 2015). *Cities: Skylines* is also a gaming simulation community with multiple social media channels, forums, wikis, and other venues for communication and networking.

Computer simulations are moving toward hyperreal, 3D environments with increasingly sophisticated interactions that are both anthropogenic and autonomous. In short, these are worlds where players both direct actions and are simultaneously affected by the "random" consequences of those actions. Simulations already have a virtual world "butterfly effect." In future simulations, the flapping wings of a *sim-butterfly* may be the inception of a *sim-hurricane*. For urban planning, the unintended consequences, or externalities, of various actions may be extremely valuable in developing highly complex scenarios (Fig. 17).

Many urban planning games can be used to educate, engage the public, and study urban development scenarios. HafenCity University Professor Alenka Poplin describes some of these benefits in more detail as part of her discussion on *serious games*:

- Applying games and simulation technology to nonentertainment domains results in serious games.
- The main idea of serious games is to get players to learn something and, if possible, have fun doing it.
- Applications range from education, health, public policy, strategic communication, cultural heritage, etc.
- Enormous potential of serious games for urban planning; it is novel and still in the initial phase (Poplin 2011).

Fig. 17 Cities: Skylines screenshot, 2015

3 Artificial Intelligence: Cyberspatial Planning

Concurrent with increasingly experiential virtual environments is the development of autonomous systems and artificial intelligence. One of the most popular games is *The Sims* in which players guide simulated people (*Sims*) in a virtual community. The game's catch phrase is "Have fun. Be powerful. Create and control Sims and play with life" (The Sims 2015). In the 1999 movie *The Thirteenth Floor*, the characters discover that they are "sims" being manipulated by players in what they perceive as the future. *The Sims* motto also pertains to this film with some rather dark consequences. As simulations become more sophisticated, the virtual "eco-system" will be designed for ever-increasing autonomy. We are racing to make the science fiction of artificial intelligence and system self-awareness a reality.

From the perspective of urban planning and design, we may wish to consider both the theoretical implications and practical applications of artificial intelligence. Having cities become more autonomous, self-regulating and resilient may be some of the clear advantages of incorporating artificial intelligence in infrastructure, information, and communication technology. The concept of a *smart community* has been around for several decades, but we should aspire for a far deeper meaning than something as simple as street light regulation.

The challenges of global population growth, global fiscal crisis, and global climate change demand urban planning and design which blends gaming principles, computer simulation scenario development, and artificial intelligence system design, monitoring, and control. Of course, we would like to remain the players and not the Sims (Fig. 18).

Fig. 18 The 13th floor, 1999

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References

BoardGameGeek. (2015). *BoardGameGeek*. Retrieved from https://boardgamegeek.com/

Campbell, C. (2015). How cities: Skylines took a great big slice of SimCity. Retrieved from https://www.polygon.com/features/2015/4/8/8340665/cities-skylines-simcity

Darrow, B. (1935). *U.S. Patent No. US2026082 A*. Washington, DC: U.S. Patent and Trademark Office.

Duke, R. D. (1974). *Gaming: The future's language*. New York: Sage Publications.

Emmerich, R. (1999). *The thirteenth floor*. Los Angeles: Centropolis Entertainment.

ERIC. (2015). *Clug, community land use game. Player's manual with selected readings*. Retrieved from http://eric.ed.gov/?id=ED072642

Feldt, A. G. (1972). *CLUG: Community land use game. Player's manual with selected readings and instructor's manual with materials*. New York: The Free Press.

Forsythe, T. (2015). *Monopoly game history/Landlord's game history*. Retrieved from http://landlordsgame.info/

Ketchum, C. (2015). *Re: Electronic urban planning simulation games* (Interview).

Kofman, A. (2015). *Les Simerables*. Retrieved from https://www.jacobinmag.com/2014/10/les-simerables/

Mazzei, R. (2007). Mack avenue: The game. *Detroit metro times*. Retrieved from http://www.metrotimes.com/detroit/mack-avenue-the-game/Content?oid=2186838

Ovolo (2015). *City rain*. Retrieved from http://www.ovologames.com/cityrain/

Pilon, M. (2015a). *The monopolists: Obsession, fury and the scandal behind the world's favorite board game*. New York: Bloomsbury Publishing.

Pilon, M. (2015b). Monopoly was designed to teach the 99% about income inequality: The story you've heard about the creation of the famous board game is far from true. *Smithsonian*. Retrieved from http://www.smithsonianmag.com/arts-culture/monopoly-was-designed-teach-99-about-income-inequality-180953630/?no-ist

Poplin, A. (2011). *Games and serious games in urban planning: Study cases*. (slides). Retrieved from http://www.slideshare.net/beniamino/games-and-serious-games-in-urban-planning-study-cases

Rizzi, P. (2014). *On the nature of gaming simulation*. Krakow: Stampa.

SimCity (2015). *SimCity*. Retrieved from http://www.simcity.com/

SNES. (1991). *Dr. Wright's urban planning guide*. Tokyo: Super Nintendo Entertainment System.

Stephens, R. B. (2015, January). Planning board games. *Oregon Planners Journal*, November/December 2012, 16–19.

The Sims. (2015). *The sims*. Retrieved from http://www.thesims.com/

Treske, E. (2015). *Planning board games*. (Correspondence).

Wikipedia. (2015). *Anti-monopoly*. Retrieved from https://en.wikipedia.org/wiki/Anti-Monopoly

Wilson, F. (1975). *City planning: The games of human settlement*. New York: Van Nostrand Reinhold Company.

Between Game and Reality: Using Serious Games to Analyze Complex Interaction Processes in Air Traffic Management

Maria Freese, Sebastian Drees, and Malte Meinecke

Abstract In 2010 the eruption of the Icelandic volcano *Eyjafjallajökull* paralyzed a large part of the European air traffic. Results were massive restrictions in the European and intercontinental air traffic. Even after canceling the aircraft grounding, airport operators, airlines, air traffic controllers, and ground handlers had to deal with the situation that the aircraft and crews were not in the places where they should have been for the correct execution of the flight plan. To be able to guarantee the most efficient air traffic, the relevant stakeholders had to cooperate. Divergent goals and interests can significantly affect a solution. Therefore this cooperative coordination is difficult. It is visible that the process of decision-making, especially in the context of air traffic management (ATM), must be investigated. Human interactions during negotiations and human performance in planning activities should be analyzed. These aspects are difficult to measure with conventional methods of real- or fast-time simulations. Serious gaming is a new method in this research field to validate complex operational concepts in the ATM field. For this a paper-based multiplayer serious game, called *Total Airport Management Simulation*, was developed. The aim of this paper is to illustrate the further development of this paper-based version. In the first section, the paper-based serious game with its main ideas is presented. Based on conducted tests of the serious game, requirements for the digital prototype were deduced. In the later part of this paper, the digital prototype with some new elements will be introduced. In summary using serious games is one possibility to analyze complex interaction processes in ATM.

Keywords Air traffic management • Decision-making • Serious games

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1 Introduction

In recent decades the aviation industry has experienced strong growth rates (TAMS Partners 2012). A further increase in the number of flights in air traffic is expected (Mensen 2013). In general airports are seen as the restricted parameter for the future growth of the aviation industry. "Today many of the large airports are already operating close to their capacity limits most time of the day" (Meinecke and Suikat 2012, p. 1; EUROCONTROL 2008). One main problem is that "[. . .] the development of airports in Germany is also limited and strict approval procedures have to be fulfilled" (TAMS Partners 2012, p. 14; Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS) 2010). It is important that "[. . .] an enhanced utilization of existing capacities by increasing the efficiency of procedures and systems" (TAMS Partners 2012, p. 14) is implemented.

At some point one might analyze the decision-making of the involved stakeholder (e.g., air traffic control [ATC], airline companies, airport company, ground handlers) in order to optimize the actual processes. At an airport the interests of each stakeholder are very different. The complexity and variety of processes is one of the greatest challenges at an airport. At most airports different operational centers (OC) are managed by each of the stakeholders, "[. . .] in which its processes are planned and optimized in a manner which is found to not sufficiently consider plans or interests of other operational units" (Jipp et al. 2011, p. 1060). A further problem is that the OCs do not communicate relevant information to other OCs. "This lack of (up-to-date) information makes it difficult to harmonize the planned operations and to estimate the impact of the own planned schedule on the effectiveness of the complete airport" (Jipp et al. 2011, p. 1060).

One possibility of increasing the efficiency and quality of service at airports in order to handle the requirements of future air traffic systems is the concept of total airport management (TAM). It was developed by DLR and EUROCONTROL and is based on Airport Collaborative Decision Making (A-CDM; Günther et al. 2006).

1.1 Total Airport Management

The concept of A-CDM provides that the various stakeholders at an airport have access to a common database. The aim should be to improve the exchange of information. The concept "[. . .] offers a basic approach of how information on airside operations could be improved and exchanged in a standardized way" (Jipp et al. 2011, p. 1060; EUROCONTROL 2006). The concept of total airport management includes decision-making processes and planning in a cooperative way. It is seen as a performance-based airport management concept and the basis for a future performance-based ATM system (Jipp et al. 2011). By ensuring the performance of the airport, all stakeholders manage their processes collaboratively (Jipp et al. 2011).

The Airport Operation Plan (AOP) and the Airport Operations Center (APOC) are two main elements in future ATM systems. “The AOP is a collaboratively agreed operational plan for the complete time horizon of TAM, which encompasses the next 24 h” (Jipp et al. 2011, p. 1061). The plan contains relevant information about flight processes. Moreover weather constraints are visible. The second key element, the APOC (see Fig. 1), is an important element to facilitate the collaborative decision-making process. It is a center to monitor, plan, and control processes. The certain operators “[...] communicate, co-ordinate, develop, and dynamically maintain joint plans and execute those in their respective area of responsibility” (Jipp et al. 2011, p. 1061). To this end, agents of the respective stakeholder groups come together in a virtual or physical control center to analyze the current situation of the airport with respect to certain criteria. In this way, planning is derived out of a cooperative process. An agent of each airport stakeholder is send into the APOC. Their tasks are to represent the stakeholders’ interests, especially in the “[...] pre-tactical airport operation planning” (Jipp et al. 2011, p. 1061). As seen in Fig. 1, general information is visualized at the video wall. This setup ensures that every agent has situational awareness of the current and future traffic situation and constraints (Jipp et al. 2011). Information may be different from stakeholder to stakeholder. For this reason every agent has its own working position. To enable an agent’s decision-making, the working position is connected to his own OC and all required information is available (Jipp et al. 2011).

It is possible that an agent starts a negotiation process especially if he recognizes that the AOP does not fit to a certain performance goal. The aim of this negotiation is to handle the predicted bottleneck and to find a common solution in a collaborative way. All in all, this concept intends to establish a new way to handle decision-making processes at airports especially under difficult and unpredictable events.

Analyzing complex decision-making processes in this environment with conventional real- or fast-time simulations is difficult (Meinecke and Suikat 2012) because the communication, the cooperation, and the decision-making process between the individual stakeholders is in the foreground and cannot be studied with traditional simulations. Serious gaming is a new method to validate complex operational concepts in the ATM field (Suikat et al. 2009; Jipp et al. 2011). Furthermore complex human interactions during negotiations and human performance in planning activities can be analyzed.

1.2 Serious Games in Air Traffic Management

Abt (1970, p. 9) defined *serious games* as follows:

> *We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining.*

Fig. 1 Airport Control Center Simulator (ACCES) at the Institute of Flight Guidance (DLR intern 2015)

In contrast to games with focus on entertainment, serious games often have a pedagogical or educational background. Serious games have their origin in military planning, but they are well established in the field of education (Abt 1970; Djaouti, Alvarez, Jessel & Rampnoux, 2011). The use of serious games is interesting because on the one hand, it may be used to study the behavior of humans in certain situations. On the other hand, it can be studied to develop human strategies to overcome given obstacles (Meinecke and Suikat 2012). Gaming scenarios can be conducted on paper (paper based). It is particularly suitable for analyzing concepts during an early stage of development (Jipp et al. 2011). It may help to evaluate the logical concept of the game to detail it. Further these gaming scenarios can also be coupled with simulations. It is called platform-based gaming (Meinecke and Suikat 2012). To distinguish serious games and methods of simulations, there exist certain attributes, which characterize both types (see Table 1). "The main difference between games and [forms of] simulations is that a game always requires some sort of conflict and win/loose situation, but does not necessarily need to duplicate reality, while a simulation does not require any specific goal or conflict between actors" (Jipp et al. 2011, p. 1062).

As shown in Table 1, a development from a simulation to a serious game is also possible. All in all, the most important difference is the amount of human interaction during serious games. Because human interactions during decision-making processes in ATM are relevant and need to be analyzed, serious gaming is the most suitable method for validating it.

A new research field of serious gaming techniques has developed. These techniques have been applied to analyze new concepts in the context of ATM (Suikat

Table 1 Essential attributes of educational games and simulations (Sauvé et al. 2007)

Simulation	(Educational) serious game
Model of reality defined as a system	Player/players
Dynamic model	Conflict/k cooperation/competition
Simplified model	Rules
True, precise, and valid model	Predetermined goal of a game
Real person	Artificial situation/characters
Educational character and its potential in helping understanding of the model-related reality	Educational character or its potential for improving learning
Fun, game elements, rules, goal, competition (Prensky 2001)	

et al. 2009). All in all, the cooperation of stakeholders in ATM has to be optimized. By using serious games, it is possible to show and analyze complex interaction and communication processes. In order to simulate APOC processes and to study features of collaborative teamwork, the paper-based serious multiplayer game from (Meinecke 2011) was used as the basis for further research. A simplified simulation of the ATM is implemented within the paper-based serious game and will be presented in the following chapter.

2 Paper-Based Serious Multiplayer Game in Air Traffic Management

The *Total Airport Management Simulation* is a paper-based multiplayer serious game. In the next chapters the main aspects are presented.

2.1 Roles

Six persons can play the serious game (see Table 2). It is also possible that fewer people play the multiplayer game and roles are distributed differently.

The common goal of all players is to reach the highest possible rating. Therefore all players can only win or lose together. The secondary objective for each agent is the highest possible economic success which enables a comparison between players. For example, it shows which airline has worked most effectively.

Table 2 Description of the roles

Person no.	Role	Description of the role
1	ATC (air traffic controller)	Closes and opens runways; places neutral airplane cards (en route) on the standard arrival route (STAR)
2	AP (airport)	Opens and closes gate entrances; places neutral airplane cards on the STAR
3	GH (ground handler)	Moves shuttle busses and pallet trucks from and to any stand
4	AL (airline red)	Places any airplane card on the STAR
5	AL (airline blue)	Places any airplane card on the STAR
6	AL (airline yellow)	Places any airplane card on the STAR

2.2 Game Board

The game consists of two phases: planning and execution phase. Figure 2 shows the AOP, which is one of the main elements of the game. The plan visualizes the most relevant planning information and is available to all players. The AOP is divided in three parts. The first part shows the arrival time and route of all flights. The second one informs about the used parking position and the last part stands for the departure time of all flights.

The second element is the game board for the execution phase. As shown in Fig. 3, the game board represents an airport with its main elements. It is "[..] structured into a Standard Arrival Route (STAR), airport gates, the lay down for the ground handler and a waiting hall for outgoing passengers" (Meinecke and Suikat 2012, p. 3). It can be varied in capacity (influences the number of busses and pallet trucks of the ground handler) and number of runways (influences the number of parking positions (STANDs)). Also there are "[. . .] markers and tokens to mark the position of aircrafts, cubes to represent fright, passengers and to save several values, as well as cards to show and plan several game actions and last but least a couple of charts to gain an overview over the status of the simulation and the turn process" (Meinecke and Suikat 2012, p. 3).

2.3 Gameplay

The game can be played for as many rounds as determined by the simulation observer. As described in an earlier chapter of this paper, one round consists both of a planning and an execution phase. Every phase is divided into seven steps. In the first phase, each player has to plan his actions for the next seven steps. For that purpose each player receives a planning tableau, on which action cards may be placed. At the end of the planning phase, each slot may or may not contain one

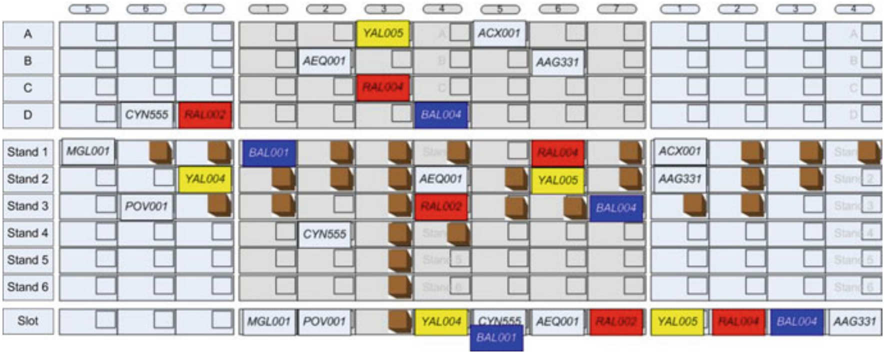

Fig. 2 Airport operation plan (Adapted from Meinecke 2011)

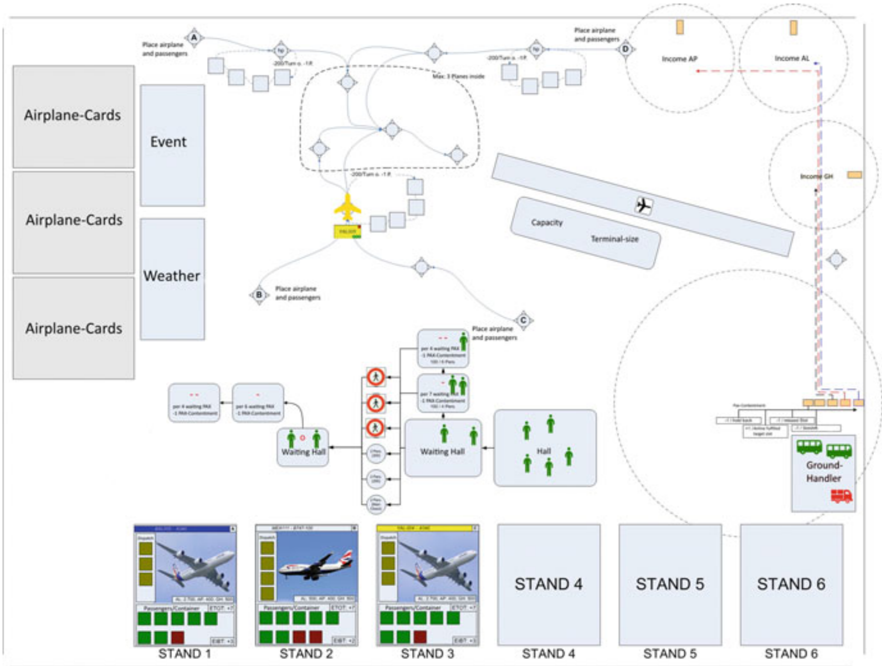

Fig. 3 Game board (Adapted from Meinecke 2011)

action card. The following action cards can be placed on a planning tableau, depending on the player role. Player roles were described in Table 2.

During the planning phase, players are required to communicate and cooperate with each other, because the placement of certain cards requires the reaction of other players. Cards which are put down during the planning phase may be picked up at any time during the same phase.

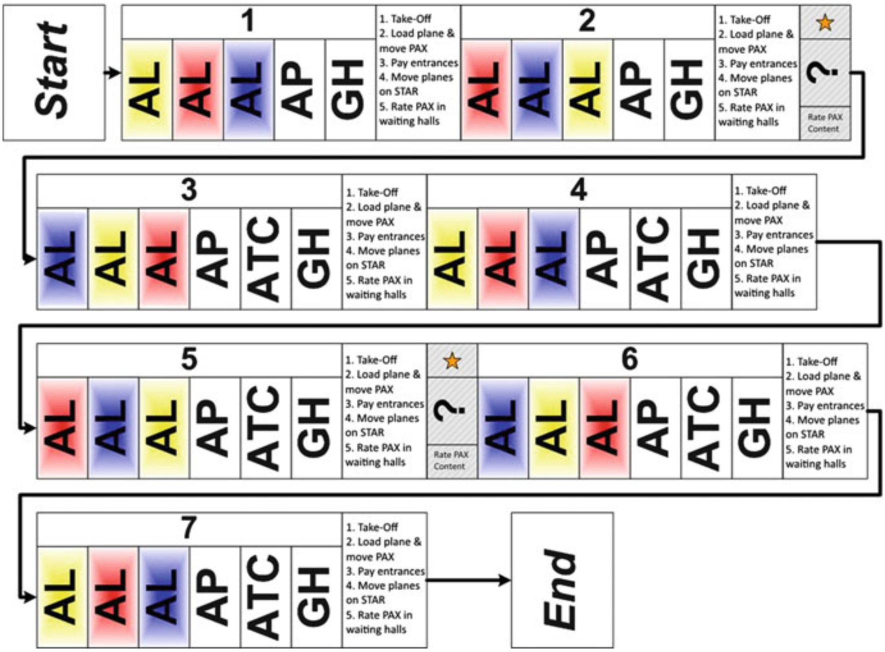

Fig. 4 Execution chart: *AL* airline (*yellow*, *red*, *blue*), *AP* airport, *GH* ground handler (Adapted from Meinecke 2011)

The execution phase follows after the completion of the planning phase. On the first field of the execution chart, a marker is placed. During each step this marker indicates the next planned move of each player (see Fig. 4). After each player's turn, ongoing processes like aircraft or passenger movements, takeoffs, and landings are simulated. The described procedure is repeated for each of the seven simulation steps. After the marker has moved behind the seventh simulation step, the last phase of a round begins. This phase serves as a preparation for the next simulation round. The end of the game is set at the beginning (number of rounds determined by the moderator) of the game.

In the next step, the paper-based serious multiplayer game in the ATM serves as basis for the implementation of the digital serious game prototype. Game-based validation methods in the context of ATM are useful mainly for human factor aspects. Due to expanding levels of complexity, a paper-based game method is not able to fulfill the same functions like computer-based approaches. As a matter of fact, the level of detail is much lower than it might be in a digital simulation. Also a certain level of abstraction is required to guarantee a suitable time needed for the simulation (Meinecke and Suikat 2012). Based on deducted playtests of the paper-based serious game, recommendations for the implementation of the digital prototype can be deduced.

3 Playtests of the Paper-Based Serious Multiplayer Game

During the development of the paper-based serious multiplayer game, a lot of tests were made (Meinecke and Suikat 2012). The goal was to test the game mechanic, certain game mechanism, and the simulation aspects. Moreover playtests with the paper-based serious multiplayer game in 2014 and 2015 were conducted ($N = 21$) to analyze the collaborative processes during the game. For each test up to seven players have participated. The groups consisted of aeronautical engineers, human factor experts of the German Aerospace Center, and an experienced game author. Every simulation took several hours. In order to evaluate the paper-based game, regarding the development of a digital version of the serious game, the playtest persons were to fill out a short survey. Additionally the playtest was recorded in writing. Especially the player roles, the collaboration between the players and the appearance of the serious game were examined in detail.

After analyzing the feedback questionnaire and the playtest record, the following conclusions were made (without prioritization):

1. The game appeared too complex at the beginning, because many game elements were not self-explaining. For that reason players were not able to apply certain strategies. Therefore an interactive tutorial for each of the player roles would simplify the start of the game.
2. As a result of the high complexity of the game, some players did not know which parameters they should optimize and therefore were less able to cooperate. Consequently the players should be able to access explanations and help topics for each element of the game at any time.
3. The "ATC" player appeared to have almost no interaction within the game. Hence, he can be substituted by an automated non-player character (NPC).
4. The "airline" players were the only participants of discussions during the planning phase. Therefore the "airport" and the "ground handler" player should have more influence on decisions during the planning phase.
5. Neither the "airport" nor the "ground handler" player was using their planning aid, which should consequently be redesigned or substituted by another planning tool.
6. The players rated the entertainment value averagely 10–20 %. In order to increase the intrinsic motivation, animations, more detailed graphics, and information about selected airplanes or parts of the airport should be included in the game and add up to a higher entertainment value. Although entertainment should not be the main factor in serious games, they may contain entertaining elements.
7. The end of the game appeared abrupt and arbitrary, because the number of rounds was not set at the beginning.

The following step is to digitalize the paper-based serious multiplayer game. Therefore some assessments of the paper-based version have to be deduced. Table 3 shows that some changes to the game should be made in order to prepare an optimal

Table 3 Selection of requirements deduced from the paper-based game

Description	Paper based	Digital prototype
Manual	Instruction manual	Help menu, responsive tooltips/warnings
Planning tools	Planning tableaux, planning aid	Planning tableaux, option to fast forward the current scenario, showing the passenger flow and arrival/departure of airplanes at each simulation step (regardless of airport and ground handler planning)
Player roles	ATC, airport, ground handler, airline	airport, ground handler, airlines
End of planning phase	Consensus	Approval of each player
Game board items	Tokens are placed by the players	Tokens are placed automatically
Temporal navigation during the execution phase	Possible at great expense	Navigation slider

implementation. The results are seen in the next chapter which is about the digital prototype.

4 Digital Prototype

In general the concept of the digital prototype includes the same concept as in the paper-based version, based on which collaborative processes in ATM are being studied. As also seen in Table 3, some further changes are needed to ensure the relation to reality and to reduce the playtime. Four persons can play the digital serious game (airline A, airline B, airport, ground handler). It is also possible to add a third Airline. The role of the ATC was fully automated because during the paper-based tests, it was visible that the tasks of the ATC were not very extensive to maintain. In contrast to the paper-based game, the instruction manual was developed into an interactive tutorial. An aircraft, serving as a tutorial guide, helps the user on the one hand to understand the most important game materials and on the other hand how to play the game. Regarding the idea of the collaborative concept, an already planned AOP is set at the beginning of the game. The focus in the digital prototype will be on new planning scenarios for incoming critical events in each round (e.g., ATC closes runway (runway repairs); airport personnel strike, passengers cannot enter Waiting hall 1 for the next three steps; busses and trucks at stand 2 need to be repaired and cannot be used; weather – storm, only two airplanes are allowed in the critical zone). The players have to react on spontaneous changes. For this, they need to communicate and collaboratively derive new plans on the basis of the already planned AOP. Because of the already planned AOP and the following replanning, it was possible to reduce the time to play the game. Additionally the digital prototype consists of simulation states, which allow a simulation preview. Therefore during the planning phase, the players are able to check their planning for any mistakes. The simulation preview shows the outcome after each step of a certain round. In this way players are able to optimize their planning, preventing loss of money, negative passenger contentment, or even a cancelation during the simulation phase, because of an impossible move. After viewing a simulation preview of the next round, the simulation state is being reset to the beginning of the round, ensuring equal simulation states for each player. Following the planning phase, the (re)planned AOP is simulated, displaying each player's changes to the AOP. The simulation of the planning, as well as the simulation preview, is being shown in a different view. To make the game board much more attractive, the places of the main items were changed and redesigned. Moreover the tokens are not being placed by the player, but also automatically being moved during the simulation phase. That way the length of the digital game could roughly be halved compared to the board game. After the simulation phase, the players have to plan the next round, which is affected by new critical events. It is the same procedure as in the rounds before (firstly planning, secondly simulation of the planned AOP). A result screen showing a score is displayed to the players after finishing the simulation of the last round. Further the score and a log of the game are saved at the server-side, which allows comparisons of different game sessions. The score follows from the calculated passenger contentment and the money earned by each player during the game (Fig. 5).

The digital version will be conducted in an APOC. The APOC is the research platform *Airport and Control Center Simulator* (ACCES) at the DLR Institute of Flight Guidance. It is designed as a highly flexible facility for ATM and airport operation research. ACCES provides a control room with a certain number of operating working position and a video wall to visualize relevant data. All in all, with the help of the digital prototype, the aim should be to research relevant decision-making processes in new planning situations.

5 Discussion

In summary it could be illustrated that airports will become a major bottleneck and existing capacities have to be utilized by increasing efficiency. Different stakeholder groups with divergent goals work at an airport. This results in complex processes. One possibility to optimize the stakeholder's collaboration is to import a common information base. The stakeholder agents should work in an APOC and plan in a collaborative process the AOP. Because especially human interactions during collaboration are of interest, serious gaming seems to be the best possibility to validate this complex interaction processes. The paper-based serious multiplayer game (Meinecke 2011) was developed into a digital prototype. The digital prototype allows the analysis of collaboration processes by comparing scores, log files,

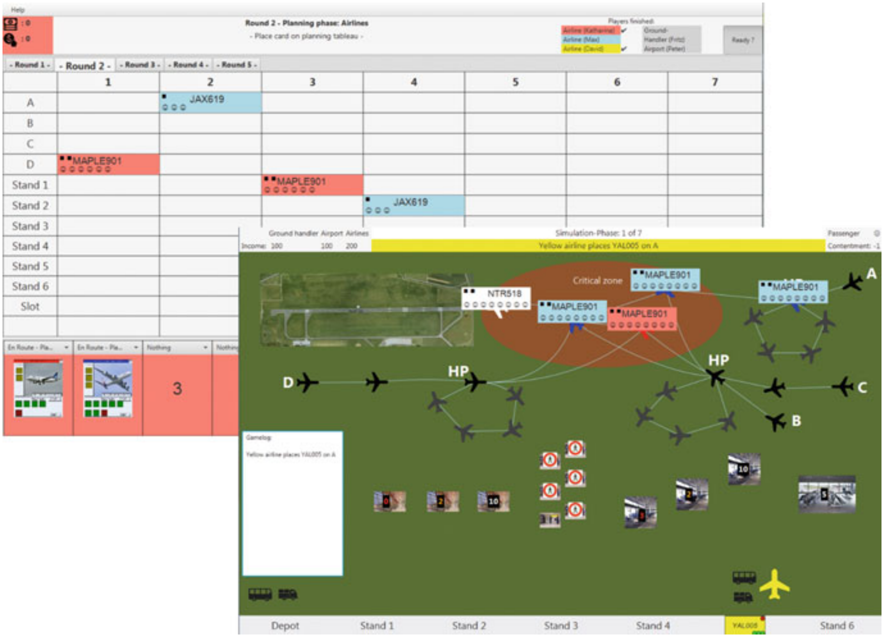

Fig. 5 Overview of the digital prototype

and questionnaires collected after multiple conducted playtest sessions. To analyze the collaboration processes, there are two main points to discuss.

5.1 Aspects of Collaborative Learning in a Serious Game

Normally serious games have a background in education. In this case complex interaction processes should be demonstrated. Nevertheless in existing digital games, there is a special kind of learning aspect: collaborative learning. "Collaborative learning is a learning situation in which more than one student participates in a common learning activity engaging them in pursuit of a common goal" (Romero et al. 2012, p. 4). This learning approach targets the enhancement of interpersonal competencies such as negotiation, collaborative decision-making, and creative problem resolution. These aspects can be achieved by the use of the collaborative game-based learning (GBL) situation, which allows a "learning by doing approach," while avoiding real-life risks. This will be achieved by the digital prototype, offering an ideal situation, in which several stakeholders of an airport operation center collaborate (Romero et al. 2012).

Each player is not only responsible for his own learning process but has also a high influence on the learning success of the group, by contributing his skill and respecting the abilities of other players. Positive interdependency can be achieved by multiplayer GBL dynamics, which define and guide the information flow among different groups. Within the digital prototype, in order to achieve their common goal of a flawless passenger flow and aircraft handling, the different players have to rely on each other's planning.

The problem which might follow from positive interdependency in multiplayer GBL is the lack of challenge, resulting in a loss of engagement. The in-group coordination and performance can be increased by supporting the competition between different groups (Erev et al. 1993; Bornstein 2003). To support intergroup competition within serious games, the performance of each group should be visible to all players (Romero et al. 2012). On the one hand, the digital prototype offers competition between different airlines, because each airline has their own economic interests, for example, concerning the aircraft handling. And on the other hand, after the end of a game, the playgroup will be able to compare their result score to the score of other groups.

In order to foster knowledge sharing and construction within multiplayer games, there should be separate communication zones for individual, intergroup, and intragroup dynamics. The players should be able to communicate with each other and have access to information, not only about their own but also about the performance of other groups. A player will be able to see his own planning tableaux and also the outcome of their collaborative planning. Furthermore he has insight on the AOP which is shared between all players. Additionally the playboard, which displays the simulation of the move of each player, is shown to all observers.

Additionally within game-based learning environments, immediate feedback should have a high priority (Dunwell and de Freitas 2011). The digital prototype will display hints and critical information, during each step of the planning phase, concerning the options of the players and effects of his planning. Each player will also see the immediate effect of other player's actions on the AOP. Further during the execution phase, the players may watch the outcome of each player's actions.

5.2 Simplified Representation of ATM Concepts

A paper-based simulation surrounding can never reach the whole complexity of a real APOC. It cannot even reach the level of detail of a computer-based simulation due to missing "bureaucracy." For everything a computer is able to calculate in the background in a paper-based game a player's task is needed. These tasks are bound to the level of complexity the board game has. Transferred back to the topic of ATM, this means the closer the game is to real airport business, the more time the players have to spend for administrative tasks to keep the game running. Due to this lack of calculation, power developers of paper-based games have to find a good balance between a highly realistic mapping of reality to stay thematically near to common airport business and fairly high level of abstraction to keep the game playable (during a moderate timespan). In the case of the paper-based game, abstraction means, for example, the loss of features like simulated ticket sale or the division between check in (airline operated) and security check (airport operated) before entering a flight. Through the development of the digital prototype, it is possible to set the focus on the relevant criteria. It is possible to represent the complex aspects of the paper-based game much easier during the digital prototype. That is why the degree of details in the digital prototype is relatively high compared to the paper-based serious multiplayer game regarding the aspects of reality.

6 Conclusion and Outlook

Serious gaming in the field of ATM seems to be a relative new research field. It is a method in the middle of gaming and the representation of reality. The digital prototype is a simplified presentation of ATM concepts but also has a higher level of details as the paper-based one. The next step is to optimize the digital prototype. Moreover the question is to answer how experts of ATM can realize the benefits of cooperation and collaboration by using serious gaming. Experiments are planned for the end of 2015.

With methods of serious gaming, it is possible to validate complex interaction processes. This is important because the number of cooperation is increasing (Roberts 2001). Decision-making processes in teams have to be examined and moreover potential influencing factors have to be analyzed. With the knowledge about it, a new way of handling decision-making processes at airports especially under difficult and unpredictable events, such as the volcano eruption in 2010, can be shown.

References

Abt, C. (1970). *Serious games*. New York: Viking.

Bornstein, G. (2003). Intergroup conflict: Individual, group and collective interests. *Personality and Social Psychology Review, 7*(2), 129–145.

Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS). (2010). *Flughafenkonzept der Bundesregierung 2009*. http://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/Luft/flughafenkonzept-2009-der-bundesregierung.pdf?__blob=publicationFile. 27 Mar 2015.

Djaouti, D., Alvarez, J., Jessel, J.-P., & Rampnoux, O. (2011). Origins in serious games. In M.

Dunwell, I., & de Freitas, S. (2011). Four-dimensional consideration of feedback in serious games. In S. de Freitas, & P. Maharg (Eds.), *Digital games and learning* (pp. 42–62, continuum publishing.). London: Routledge.

Erev, I., Bornstein, G., & Galili, R. (1993). Constructive intergroup competition as a solution to the free rider problem: A field experiment. *Journal of Experimental Social Psychology, 29*, 463–478.

EUROCONTROL. (2006). *Airport CDM operational concept document*. URL http://www.euro-cdm.org/library/cdm_ocd.pdf. 27 Mar 2015.

EUROCONTROL. (2008). *Long-term forecast: IFR flight movements 2008–2030*. URL https://www.eurocontrol.int/sites/default/files/field_tabs/content/documents/official-documents/forecasts/long-term-forecast-2008-2030.pdf. 27 Mar 2015.

Günther, Y., Inard, A., Werther, B., Bonnier, M., Spies, G., Marsden, A., ... Niederstrasser, H. (2006). *Total airport management*. Verfügbar unter http://www.bs.dlr.de/tam/Dokuments/TAM-OCD-public.pdf. 27 Mar 2015.

Jipp, M., Depenbrock, Suikat, R., Schaper, M., Papenfuß, A., Kaltenhäuser, S., & Weber, B. (2011). Validation of multi-objective optimization for total airport management. *Proceedings of the 8th Asian Control Conference (ASCC), Kaohsiung (Taiwan)*.

Meinecke, M. (2011). *Bewertung von total airport management Konzepten mit Hilfe eines Spielbasierten Ansatzes*. Unpublished Bachelor-thesis, German Aerospace Center (DLR), Braunschweig.

Meinecke, M., & Suikat, R. (2012) Evaluation of total airport management concepts via a game-based approach. *30th European annual conference on human decision-making and manual control (EAM), Baunschweig*.

Mensen, H. (2013). *Handbuch der Luftfahrt* (2nd ed.). Berlin/Heidelberg: Springer.

Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.

Roberts, E. B. (2001). Benchmarking global strategic management of technology. *Research-Technology Management, 44*(2), 25–36.

Romero, M., Usart, M., Ott, M., Earp, J., & de Freitas, S. (2012). Learning through playing for or against each other? Promoting collaborative learning in digital game based learning. *Proceedings of the European Conference on Information Systems (ECIS)*. URL http://aisel.aisnet.org/ecis2012/93. 27 Mar 2015.

Sauvé, L., Renaud, L., Kaufman, D., & Marquis, J. S. (2007). Distinguishing between games and simulations: A systematic review. *Educational Technology & Society, 10*(3), 247–256.

Suikat, R., Weber, B., & de Jonge, H. (2009). *EPISODE3 – simulation report on collaborative airport planning*. URL http://www.episode3.aero/library/wp3/wp33_validation/wp3.3.4-collaborative-airport-planning/d3.3.4-02-simulation-report-on-collaborative/E3-WP3-D3.3.4-02-REP-V1.00-simulation-report.pdf. 27 Mar 2015.

TAMS Partners. (2012). *TAMS operational concept*. http://www.tams.aero/documents/konzeptdokumente/TAMS_OCD_v-1-0-1_public.pdf. 27 Mar 2015.

Gaming Simulation Hybrids in the Railway Domain: How Games Impact the Volatility of Innovation Processes

J. Van den Hoogen and S. Meijer

Abstract Innovation processes in the railway domain are highly chaotic due to the reciprocal influences of technological, social, and institutional dynamics over time. The ways by which gaming simulation can contribute to these processes is therefore highly context, time, and history dependent. Using three case studies, we explore basic recurrent patterns in these innovation processes and how the employment of gaming simulation has alleviated or attenuated these patterns. For different product architectures that characterize the innovation artifact, different patterns arise in different sequences for the process. We conclude that gaming's main active substance is in the opening up or closing down of technological, social, and institutional spaces. In addition, this impact is again highly moderated by the specific constellation of these spaces when a game is designed, executed, and analyzed. Broadly we see that in stable times, gaming simulation is able to decrease stability and thereby front-load much of the volatility otherwise found at later stages of the innovation process. In contrast, gaming simulation's ability to decrease volatility in volatile times is more problematic.

Keywords Simulation • Gaming • Innovation processes • Chaos • Complexity

1 Introduction

Innovation processes are inherently chaotic (Cheng and Van de Ven 1996; Anderson and Joglekar 2012). These processes have a technological, social, and institutional component (Geels 2002). Innovation is hence as much about technological change as it is about the change in the constellation of human actors and institutions around it and the coevolution of these components over time (Carlsson and Stankiewicz 1991; Hekkert et al. 2007). From a control perspective, this chaos is

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cumbersome as it hinders innovation actors to foresee and anticipate future trends in the innovation process. Then, learning plays a key role in managing this chaos. According to Van de Ven (1986), learning can either create divergence (and more chaos) or convergence (and less chaos). Taking this notion into account, we look at how the use of gaming simulation impacts this chaos in innovation processes. We use this approach for two reasons: firstly, the gaming simulations we have employed for a range of innovation processes in the railway sector served the purpose of research, i.e., the learning of innovation managers through the experimental use of simulations of sociotechnical systems with real-life operators as game players. Therefore these gaming simulations are perfect examples of hybrids of games and simulations. Secondly, gaming simulation is used for both explorative and explanatory purposes. This to a large extent overlaps with the notion of divergent and convergent consequences of learning in innovation processes.

This paper builds upon earlier empirical work on emergent patterns in innovation processes. Here we identified the level of chaos as the volatility in the product, social, and institutional spaces that characterize an innovation process. This volatility is the key determinant of process complexity. Highly volatile situations, where the innovation artifact, the actor network that designs it, and the applicable institutions change rapidly, create many unforeseen consequences. Although dynamics in different spaces of the innovation are deterministically linked, those involved in managing the process have no way to predict with certainty how the process will evolve. We explore the role of gaming simulation in either artificially creating volatility beforehand or in diminishing volatility at the moment it occurs. We therefore pose the question: *through what ways is the use of gaming simulation able to influence volatility patterns during an innovation process and what contextual factors moderate this influence*?

2 Innovation Processes

In general innovation scholars adopt one of two standard perspectives on innovation processes. The first is linear, perceiving these processes to move through orderly phases such as discovery, development, and implementation. The linear perspective is often used because of its elegance and its seemingly practical utility. For instance the stage-gate model of Cooper (2011) instructs organizations to orderly manage innovation processes by bracketing it into separate stages and to build gates to filter those promising innovations deserving further attention and investments. These linear portrayals of innovation enable gaming simulation scholars to signal where what types of simulations are most suitable. Similar to how Kriz and Hense (2006) linked different games with different stages in organizational development, we could see that more diagnosis-oriented games allow for discovery, whereas testing oriented games and training games, respectively, allow for development and implementation.

In much of our empirical work, however, we have found that linear conceptions on innovation processes do little justice to the chaos, contingency, and complexity of bringing about innovations in sociotechnical systems. It is for this reason we adopt the second perspective: innovations are inherently nonlinear. We have seen the following discrepancies, some of which are typical for sociotechnical systems:

1. Sociotechnical systems are rigid due to the interdependence between coevolved technologies, routines, norms, and user practices. This constellation is termed the sociotechnical regime (Rip and Kemp 1998).
2. Innovations emerge from niches. Environments which are less structured than the incumbent system, i.e., the sociotechnical regime, and provide shielding from the selection pressures of this regime (Geels 2002).
3. There is a constant battle between the sociotechnical regime and the innovation that will invade this regime (Rip and Kemp 1998; Geels 2002).
4. Innovations change over time through this interaction and through interactions with concurrent innovations (termed interlocking mechanisms, see Geels 2005).
5. The actor networks and institutions around the innovation artifact are highly fluid. Decision makers and designers enter and leave the arena involved in bringing about the innovation. They bring to the arena new insights, new perspectives, and new incentives.
6. In some instances, these interactions lead to the convergence of visions, learning, and the building of actor networks. This gives an innovation momentum, which is needed for the innovation to defy pressures from concurrent innovations and the incumbent system (Hoogma et al. 2002).

Adding up all these discrepancies prohibits us from simply assuming that innovation processes consist of orderly separated stages. Discovery, development, and implementation are of course activities that occur throughout the process, but the strict sequential order of these cannot be assumed. These activities can occur in different orders, are carried out by different parties, or might take place simultaneously. Given that game design as design-in-the-small (DIS) is highly related to design processes that the game should support as design-in-the-large (DIL) (Klabbers 2006), the notions of nonlinearity and chaos impact the way we look at gaming simulation's value. It then becomes fuzzier where during the process what type of gaming simulation should be used.

2.1 PSI Framework

We use the PSI framework shown in Table 1 (Meijer et al. 2014), originating from the fields of engineering design, to study microlevel innovation processes. The PSI framework originally intends to characterize design as taking place in three distinct spaces. For the purpose of describing innovation processes, we use the PSI framework to analyze the movement in three separated but interrelated spaces: the product space, the social space, and the institutional space. With these dimensions

Table 1 PSI framework (Meijer et al. 2014)

Space	Dimension	Explanation
P (product)	Structural complexity	Interdependence between system components
	Amount of disciplines	Amount of qualitatively different disciplines involved in designing the artifact
	Knowledge availability	Completeness of knowledge needed to design the artifact
S (social)	Amount of languages	Amount of different vocabularies used to describe the artifact
	Amount of perspectives	Amount of different perspectives on artifact and its functions
	Inclusion	Ease by which actors can enter the S space
I (institutional)	Strength of ties	Weak versus strong ties
	Coordination mechanism	Market versus hierarchy
	Knowledge accessibility	Ease by which knowledge can be accessed

we stay close to notions on system innovations as the coevolution of technology, actor networks, and institutions over time (Hekkert et al. 2007).

The PSI framework provides an analytical framework to describe the structural parameters of an innovation process. Furthermore the framework postulates that ideally changes in one of the spaces need to be accompanied with changes in other space. For instance, if the innovation artifact becomes more complex over time (increase in P), then the actor network should expand as well (increase in S). In addition, the PSI framework specifically acknowledges the nonlinearity of innovation processes since it does not assume any sequence of phases beforehand.

3 Recurring Patterns

In the past 3 years, we have studied a range of innovation projects in the Dutch and UK railway sectors. For this paper we provide three case studies on projects that differed on the specific location in time of volatility in the P, S, and I spaces and incorporated the use of gaming simulation hybrids as means to explore or test certain innovations. Furthermore they differed along two dimensions: the internal interdependence of innovation elements and the overlap of innovation elements with external elements from concurrent innovations or the incumbent system. The three case studies are:

Spoorzone Delft (SZD) – The building of a railway tunnel through the city center of Delft. A highly systemic product, which shares much overlap with the regime given technical standards, operator procedures, and safety installations.

Traffic Management System (TMS) – The radical overhaul of traffic control processes in the UK combined with a new traffic management system. A highly systemic product, which over time created much independence from the environment (concurrent innovations and the regime) through the purposeful design of interfaces.

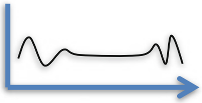
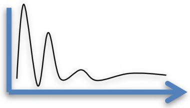
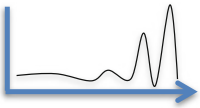
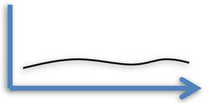
Robust Railways (RR) – The introduction of Japanese design and operating principles in the Dutch railway system. A collection of loosely related elements, which involved the reconfiguration of already existing regime elements. Hence, the niche and the regime, and other innovations, had much overlap.

The amount of volatility a certain innovation allows for and its location in time is highly determined by the rigidity and the momentum that is created by actor networks investing heavily in this innovation. When an innovation artifact is fully developed and many parties have invested considerable time, money, and effort in this innovation, the entrance of a new actor in the network will cause little changes in the innovation artifact. We then found that, given this notion, certain types of innovation artifacts allow for this buildup of momentum (TMS and to a lesser extent SZD), whereas others were more suitable for interlocking processes with concurrent innovations and the regime (RR and to a lesser extent SZD). Key to this notion is that innovation artifacts are rarely atomistic products but more often a set of different innovation elements. We have seen that it is the level of interdependence between internal innovation elements and between innovation elements and the environment that impacts highly where, in time, the volatility was located.

Table 1 provides a short overview of the three different innovation artifacts and the related volatility patterns. Note that the classifications of internal and external interdependence say nothing about the radicalness of the innovation itself. Innovations that are internally highly connected (and hence systemic) create the need for the early buildup of momentum. These innovations need to collaboration of many different stakeholders in the beginning of the process. Hence we see dynamics in the P, S, and I spaces mainly at the front end. Because of its systemicity and the momentum it builds, it is able to withstand more of the regime pressures later on. Furthermore, the innovation artifact itself becomes more rigid over time, not allowing for interlocking mechanisms with other innovations in later stages.

The mirror image is that of innovations that are internally loosely coupled but share many overlaps with external elements either belonging to the regime or to concurrent innovations. The sharing with other elements often lies in the fact that these types of innovations involve the reconfiguration of regime elements. Unlike the aforementioned innovation, these reconfigurations do not involve the adding-on of some new technology. Rather they intend to reshuffle already existing elements. An example would be the idea to increase capacity on the railway network by redesigning the total constellation of railway tracks, signaling, and overhead wiring (part of RR). Here the lack of momentum and the ease by which interlocking mechanisms occur later on create volatility mainly at the back end of the process. An overview is shown in Table 2.

Table 2 Volatility patterns for four different innovations

Overlap interdependence	External high	External low
Internal high	1. Large civil engineering upgrades (SZD)	2. System add-ons (TMS)
		
Internal low	3. Reconfiguration of regime elements (RR)	4. Simple add-ons
		

3.1 *Spoorzone Delft (1)*

Spoorzone Delft involved the building of a railway tunnel through the city center of Delft, including a new underground railway station. The interdependencies between innovation-internal elements were strong, as all elements were needed for the tunnel to function properly. Furthermore the overlap with the regime was profound in that the tunnel should allow for standard operating procedures regarding tunnel operation, traffic control, and emergency protocols. Regime players from the incumbent system mandate these procedures to maintain interoperability.

For handling the project, project members adopted standard systems engineering principles to structure work processes mainly related to the technical parts of the tunnel. Firstly, this involved specifying all requirements beforehand, i.e., determining what procedures the tunnel should allow for. Secondly, this involved hierarchically structuring the design: from an overall grand design to more detailed modules beneath it. This way, coordination was mainly realized using hierarchy where higher-level designs constrain the degrees of freedom for lower-level designs. This approach caused many perspectives and disciplines to be involved mainly in the beginning of the process. Later on, when designers could work on their specific part in modules, the work became more specialized.

Respondents acknowledged that this approach has its disadvantages. Faulty modularization creates interdependence in designs without coordination between design teams. This can cause modules to not fit properly when reintegrated in later stages of the process. It is cumbersome to design modules in such a way that after reintegration the overall artifact still adheres to the requirements specified beforehand. Modules create compartmentalization and each module might be impacted by its own eigendynamic as well as impacted by external pressures.

At SZD such phenomena were expected given experiences with similar projects. The project team therefore puts up an extensive testing regime. This involved testing elements on the module level, as well as testing conjunctions of modules and the final overall artifact. Since only the final artifact is safe enough for operation, the conjunction between artifact and procedures is only tested in the final stage of the project. As respondents acknowledged, the highest complexity could be found at this part of the process. In previous tunnel projects, given the momentum already built up by the technical artifact, actors had to choose between costly technical changes or locally adapted procedures that endangered interoperability.

Adding to the complexity for Delft was the fact that testing the entire tunnel in its final stages could only be done in a few days rather than the usual 6 months due to spatial constraints on placing temporary infrastructure. Foreseeing potential problems, the project team instigated an additional commissioning team that encompassed both members of the project and members of organizational entities that would eventually use the tunnel. It mainly sought to update final users on the progression of the project. It was this commissioning team that decided to conduct a so-called integrated procedural acceptance test (IPAT).

In the spring of 2013, the team conducted several days of scenario testing where representatives from all relevant stakeholders were asked to play realistic scenarios on a scaled-down prototype version of the railway tunnel. Game players were mostly members of the commissioning team with a few additional operators invited ad hoc. The prototype version included all real-life software of the tunnel as well as realistic user interfaces that would be installed in control centers. Scenarios involved for instance the managing of train traffic and tunnel operations in case of a fire at the station platform. The intention of the IPAT was to show where the technical artifact and the procedures to use it would not match. In that sense, the game was highly exploratory as the involved actors had little hypotheses beforehand on where these mismatches could be found.

The exploratory nature of the IPAT proved to be highly effective. By running a multitude of scenarios in quick fashion, and by having operators not fully immersed, the session resulted in a dialogue between engineers and users. This resulted in a list of 50 issues where technical and procedural elements of the tunnel did not match well. These issues were quite similar to issues found in tests for similar tunnel projects with the notable difference that now, due to the time still available, the technical artifact was more flexible and less costly to change. Furthermore representatives from different operational entities such as traffic control and fire brigades played the game. These representatives were operationally knowledgeable enough to validly play the game. This created the effect that the debriefing allowed for a more creative exploration of solutions as well as supported the coordination between these solutions. Respondents specifically acknowledged that the improved communication between different actors in the debriefing resulted in a more careful balancing between technical and procedural solutions or combinations of these two. This was, according to them, strikingly different to real-life tests where collective debriefing is impossible due to distances in space and time between stakeholders and where the role of test participant and the role of designer are separated. In addition, the installation of a commissioning team made sure that all stakeholders, also those otherwise only involved in later stages, could

Table 3 Spoorzone Delft game

Usual pattern	State before game	Game design	State after game
Contraction of P space due to modularization; rising complexity and amount of languages during reintegration of modules	Simple P space, technical artifact still flexible. All elements still modularized	High realistic game model	Expanded P space. Many complexities found involving the fit between technical and procedural elements
		Exploratory	
		No dependent variable used	
		Low immersion	System now seen from multiple disciplines (not solely technical)
		Game partly played by representatives from S and I space	
		Many scenarios	
Volatile S space at beginning and end of process. Midway usually separated over different disciplines with little interdependence	Expanded S space due to installation of a commissioning team. Many different languages, perspectives, and high inclusion	Participative design	Unchanged. Commissioning team remained active until final commissioning of tunnel in February 2015
		Open session	
		Many game players, observers, and facilitators from different disciplines	
Clear I space for modularizing tunnel elements. Later on unclear when different elements do not fit (during integration)	Unclear how mismatches between technical elements and procedural elements need to be resolved	Representatives of I space played game or were observed. Created coordination mechanism on the spot during debriefing	Clear handling of expanded P space through institutions agreed upon during debriefing. Low transaction costs due to buildup of trust before game

contribute to the design of the game and relevant scenarios and participate in the simulation itself. This improved the commitment to action afterwards. The summarized findings can be found in Table 3.

3.2 *Traffic Management System (2)*

This project involved a radical overhaul of the traffic control processes in the UK. Network Rail, the UK infrastructure manager, found that other countries had partly automated their traffic control process and expected that a similar move would impact the reliability of their network as well. Especially the focus was to make the system more resilient to disruptions. Core of the program was to consolidate traffic control from 800, sometimes manually operated, signal boxes to 12 regional control centers, the design of new job roles and procedures for operational staff and the support through a yet to be procured traffic management system. Traffic management systems by themselves are highly singular products, and the relation with the designed job roles and procedures was strong and profound.

Respondents from this project saw two distinct phases in the project. The phases were separated by a sudden push for implementation and the handing over of the project to the project department of Network Rail. Many external circumstances such as budgeting cycles and increasing pressures from the government to increase the reliability of the network created this sudden shift. Before this the project team focused mainly on studying how other countries had updated and partly automated their traffic control processes. This phase was highly exploratory looking at what to implement and how to do this.

The shift caused many of the volatility found in earlier stages to settle down for two reasons. Firstly clear institutional structures were put up, such as the decision to buy the TMS from the market, rather than to develop it themselves and to invite many parties for the tender. Secondly, in order to do so, the project team deliberately made the TMS independent from other innovation processes at that time. They intentionally created interfaces between the innovation and the incumbent system, and they, to some extent, neglected potential synergies with concurrent innovations. Because of this, the complexity of managing the innovation process was mainly stemming from internal dynamics. The TMS had to be designed for a set of procedures that were not fully specified yet, while the project team was responsible for both. Contrary to the Spoorzone Delft case, were procedures were mandated by the regime, the project team's goal was to design these procedures themselves and from the ground up. Hence, whatever TMS was to be procured, the system needed to allow for these new roles and procedures. However, it remained uncertain what roles and procedures would work and be in place by 2030.

Because of this uncertainty, the TMS project team employed two gaming simulations. The first was to determine to what extent the envisioned job roles and procedures would be valuable, regardless of the TMS, and the second was to determine to what extent the systems would support these roles and procedures. Whereas the first was explanatory, hoping to confirm that the designed procedures were valuable, the latter was exploratory, similar to the SZD case.

For the first purpose, we built a paper-based gaming simulation for the Leeds area. The game (see Table 4) involved a realistic model of the infrastructure, the timetable, and the scenarios. Game players were assigned the new roles and procedures and had to solve the disruptions to best of their capabilities. The gaming simulation showed that the principle behind the new job roles and job procedures worked and provided the project team more certainty that the new roles would be valuable. This decreased the complexity as the job roles could be used as lead functions, i.e., anchoring points, for the development of the TMS. In the subsequent development of the TMS, its value would always be evaluated in the light of adherence to the new operating procedures.

To test to what extent the proposed TMS systems would be able to do so, the project team invested in an extensive test environment. They asked the three suppliers who were taking part in the tender to build model offices of the TMS systems to test the systems in conjunction with operators and the new roles and procedures. In 3 months, three teams of traffic controllers worked on scenarios in real time in all of the three different model offices. The game resulted in

Table 4 Leeds game

Usual pattern	State before game	Game design	State after game
Decreasing complexity in P space due to buildup of momentum and interdependence from other innovations	Remaining complexity involved designing both new procedures and TMS in conjunction	Low tech, but high realism in processes Explanatory Experimental High immersion Few scenarios	Allowed procedures to be anchored. Allowed project team to shift the focus to TMS
Compartmentalization due to modularization in P space. Low inclusion and decreasing amount of perspectives	One project team involved in both designing procedures and specifying the requirements for the tender of TMS	Closed game design process and execution No outside observers	Little change in S space
Clear I space due to existing project management methods. Focused on buying TMS off the shelf	Clear I space allowing project team to transfer all actions from game to outside parties		Procedures now served as method to evaluate different TMS systems

300 additional requirements. Bringing some of the operational staff that played the game to the project team helped in reducing this number to a workable 150. In some sense, the debriefing therefore went on far beyond the direct execution of the game.

To a much larger extent, this second simulation was part of the usual institutional rule setting for project management and tendering. The way additional requirements to the TMS were retrieved and handled, compared to the first simulation, was highly predetermined. The project team could simply put all requirements in the tender. The complexity of adhering to these extra requirements was then transferred to private parties. This created a commitment to action, not so much because of the game itself but more because of the institutional environment in which the game was conducted (see Table 5).

3.3 *Robust Railways (3)*

Robust Railways is a program to overhaul the design and operation of the Dutch railway system. As a benchmark, Japan proved that a completely different configuration of the same technology could result in higher capacity and higher punctuality against lower costs. Hence, within certain parts of the organization of ProRail, the idea arose to reconfigure the Dutch railway system. This entailed for instance corridor separation, signal optimization, removal of railway switches, new traffic

Table 5 Model office game

Usual patterns	State before game	Game design	State after game
Decreasing complexity in P space due to buildup of momentum and interdependence from other innovations	Procedures were anchored and served as input for testing TMS. TMS fully developed	Highly realistic Real time Many scenarios Exploratory	Expanded P space by showing mismatches between procedures and TMS
Increase compartmentalization due to modularization in P space. Low inclusion and decreasing amount of perspectives	Design team of TMS (of private parties) separated from project team. Communication via strict tender procedures	Game played at suppliers. Allowed for extensive communication between project team, game players, and TMS engineers	Players seconded from TOCs to further assist in TMS project. Separation between project team and suppliers mandated by law
Clear I space once existing project management methods were used. Focused on buying TMS off the shelf	Clear I space allowing project team to transfer all resulting actions to outside parties	No design needed for institutional structure. This was given beforehand	No change

control procedures, and more reliable assets. Rather than adding on something new, it involved the reconfiguration of existing regime elements.

The mirroring images lies in the fact that internally the innovation elements are less interdependent. Signal optimization or more reliable assets in themselves already could prove to be valuable, regardless whether the rest of the measures are implemented or not. Secondly, many of these measures are focused on elements that are also the focus of regime players. For instance, optimizing the placement of signaling alongside railway tracks has an impact on capacity and punctuality (focus of the innovation project team) as well as safety (focus of regime players). Because many of the measures are highly reversible and are less part of a web of interdependent measures, the single measures are highly influenced by external pressures. Because of these features the volatility pattern is also a mirror image of the Network Rail case. The little need to build momentum combined with the heavy external pressures later on during implementation creates volatility especially at the later stages of the innovation process.

The team involved in bringing about these principles chose not to turn the innovation in one project. The overhaul of infrastructure would simply be too costly. Rather, they created interlocking mechanisms with other projects that were planned. They sought to introduce the Japanese principles at the already planned upgrades of the Utrecht central station, the central hub of the Dutch network, and the Schiphol Airport–Lelystad corridor. Normally, such projects are handled using a so-called waterfall model where more strategical and longer-term design choices (such as infrastructure design and timetables) precede more tactical design choices (such as safety signaling placement) and operational design choices (such as local station layouts and traffic control procedures). However, problematic was that the innovation itself entailed coherent changes in all these layers: from infrastructure layout to optimized signaling and to traffic control procedures.

In 2011 a project team from the traffic control department decided to conduct a gaming simulation to test the feasibility of corridor separation for traffic controllers. The renovation of Utrecht Central station, to be finished by 2015, would create more independence between two heavily used corridors that both passed this hub station. Both corridors were highly connected through railway switches. Their removal would leave fewer options for traffic controllers to divert traffic in case of disruptions. The gaming simulation, called NAU, was comparable to the LEEDS game in that it focused on testing a hypothesis. The game was a paper-based simulation using realistic timetables, infrastructure, and train movements. Game players were traffic controllers and train and personnel planners from different stakeholders as well as from different echelons. Given that the game was realistic and played in real time, game players were highly immersed. Because the game model incorporated many different processes, the design of the game was highly participative and many stakeholders were involved in the design, facilitation, and analysis of the gaming simulation session.

NAU showed that corridor separation was feasible, also for traffic controllers who now had different choices to make in case of disruptions. However, simultaneously the game also allowed for exploration of other related issues. It showed that for the measure to be effective, the traffic control department needed better procedures for handling disruptions in advance as well as better communication between higher echelons of traffic control. These insights were not expected, so the exploratory nature of the gaming simulation was mainly a welcome side effect. Especially the debriefing between players, facilitators, and observers led to these insights. Noteworthy however is that this expansion of the scope of the project also led to discussions between the infrastructure manager and the main train operating company about the directions in which the program was heading. It therefore remained uncertain what institutions to use to coordinate actions (Table 6).

For the Amsterdam Airport–Lelystad corridor, the project team responsible for designing the infrastructure thought a gaming simulation would be helpful in determining which of the variants they considered scored best on managing disruptions. The variants ranged from only an extra track for overhauling at the station of Weesp to a variant where the entire corridor would see doubling of tracks. The organization organized the gaming simulation only weeks before a letter to the government needed to be send about which infrastructure expansion was needed. Usually this would be the one that satisfied most involved actors, and with the city of Almere demanding complete doubling of tracks, this would have resulted in the most expensive solution. However, with budgetary constraints and the notion that "Japanese" measures could help in accommodating higher traffic volumes with less infrastructure, the designers wished to test more variants.

We designed the game initially to allow for the testing of four variants. Hoping to end with one, we intended to decrease volatility in the process. However, during the design of the game, many more changes in the innovation artifact become apparent. These were last-minute changes in the variants themselves, additional

Table 6 NAU game

Usual pattern	State before game	Game design	State after game
Rising complexity and amount of disciplines in P space	Relative stability in P space. Separation of innovation elements over different organizational entities	Highly realistic game model Model contained many different processes High immersion	Decrease in complexity: game showed feasibility of innovation. Increase in complexity due to insights about additional measures
Boundaries of S space increasingly fluid. From highly secluded in the beginning toward open at the end due to multiple interlocking mechanisms	Still clear boundaries for S space. Traffic control department solely involved in changing operating procedures for Utrecht central station	Game model with many different processes demanded a participatory design process. Many outside facilitators and observers. Collective debriefing with stakeholders	Amount of languages remained equal. Mostly operational layers involved (from different stakeholders). Inclusion increased, more cooperative efforts instigated
Increasingly fuzzy I space as multiple innovations with different I spaces interlock	Clear institutional structure for implementing traffic control changes	Debriefing allowed for determination of concrete actions and the coordination of these	Unclear. Insights led to a plethora of actions, programs, and projects. Controversy on direction of innovation

variants, and different additional innovations that could potentially be implemented simultaneously. The gaming simulation appeared to be a window of opportunity to test other innovations as well. For instance, with now five variants, the project managers wanted to test the sensitivity of the results to the introduction of ERTMS, an innovative European-wide traffic management system, and the introduction of additional rush hour trains. For the experimental design, which begged a simple pretest–posttest, this created many problems. Firstly, the explosion of variants resulted in an infeasible factorial design: about 30 runs would be needed. The situation therefore demanded from us to make the simulation more abstract. Because game players were less immersed, they were better able to evaluate all proposed measures on the spot. This resulted in a plethora of qualitative insights, which could have been very valuable for the process. However the gaming simulation was designed and conducted in a highly secluded S space. Outsiders who had a stake in the upgrade of the railway line were not involved in the design, execution, and analysis of the gaming simulation. It was therefore problematic to communicate the insights to these stakeholders (see Table 7 for an overview).

Table 7 OV-SAAL game

Usual pattern	State before game	Game design	State after game
Rising complexity and amount of disciplines in P space	Highly volatile P space. Many different last-minute design changes	Intended to be explanatory. Many scenarios resulted in exploration	Little effect on decreasing complexity. Rather expanded the P space
Boundaries of S space increasingly fluid. From secluded in the beginning toward open at the end due to interlocking mechanisms	Expanded S space. Involvement of many different disciplines and languages: infrastructure managers, municipalities, train companies	Expanded S space not involved in design and execution of game because infeasible to determine who should be involved. Low inclusion	No change in S space. Therefore expansion in P space was not met with actors in S space willing to act upon the results
Increasingly fuzzy I space as innovations with different I spaces interlock	No clear institutional structure. Many, but weak, ties between actors	I space not incorporated	No change in I space

4 Synthesis

Gaming simulation is able to cause convergence and divergence. In some instances, the gaming simulation opened up the P space by showing additional complexity or by bridging different disciplines. Furthermore gaming simulation was able to allow for outsiders to enter the S space, creating diversity in languages and perspectives. In other instances, gaming simulation did the opposite. It allowed project managers to contract the P space and decrease complexity and the amount of disciplines. Furthermore, it could show what actors were needed for successful implementation of the project and hence allow the S space to be closed for others.

One design parameter that influences this effect of gaming simulation appears to be the rigor by which it is employed as an experiment. Few scenarios, high immersion, clear dependent variables, and the use of realistic models increased the extent to which the game could bring convergence in designs and perspectives. On the other hand, exploratory effects were realized using a multitude of scenarios, lower immersion, and more communication between players and observers during game play. The insights that exploratory gaming simulation can deliver are only capitalized on when observers are used and an extensive debriefing takes place.

Looking at the dynamics in P, S, and I spaces beforehand showed us that the relation between game design and effects on volatility is highly history dependent. This is because for explanatory games, which should test hypothesis rather than generate them, game designers need a clear and stable P and S spaces. However, in instances where convergence is needed to counter the high volatility, the P and S spaces are inherently unstable. The OV-SAAL game perfectly shows how gaming simulation was unable to allow spaces to converge. In the instances were convergence was realized (LEEDS and NAU), this was ensured by having the game focused on specific subset of an innovation. This made it easier to determine the game model and the actors needed to create commitment to action.

For exploratory and divergent purposes of gaming simulation to be valuable, it needs an expanded S space to co-align with the expansion of the P space. At the Delft case, this was ensured by the installation of the commissioning team prior to the execution of the game. Given that the game was designed, executed, and debriefed by this commissioning team, the already existing trust between stakeholders increased the commitment to action. Therefore the many qualitative insights were countered with effective measures. For the model office game, the expansion of the S space took place during the gaming simulation, and the already designed I space for handling the results led to commitment to action.

5 Limitations

The findings presented here solely deal with exploring and testing certain final solutions. However, systemic innovations often are characterized by equifinality (Van Alkemade et al. 2009): the same end result can be achieved in multiple ways. This holds especially for innovations that can be easily modularized and bracketed (i.e., innovations with low internal dependency). We have so far neglected the extent to which gaming simulation can contribute to finding these distinct pathways. This is however highly relevant since complex systems inherently have multiple local optima (see the fitness landscape literature: Kauffman 1993; Frenken 2006).

The presence of local optima when planning a systemic innovation (jumping from one to another locally optimal system configuration) poses several problems. Firstly, a temporary decrease in fitness is inevitable. What pitfalls are to be expected when the current system is transformed into the new system? Secondly, multiple optima create controversy about where the system in its entirety should be heading. Will stakeholders' actions sum up or conflict with each other?

We have seen how more general mechanisms of gaming simulation (see the 5C framework of Duke and Geurts (2004)) can help in alleviating many of these problems, especially by ensuring a so-called multilogue between the involved stakeholders. For instance, often the game players are well able to point to the pitfalls of implementing a systemic innovation. Our work as of now, however, does not help to more intelligently use these mechanisms for game facilitation and debriefing of exploratory and explanatory research games. This is certainly a theme for future research.

6 Conclusion

The active substance of gaming simulation, when employed in innovation processes, is the manipulation of volatility. In several cases the method has shown its ability to either front-load volatility or to decrease volatility. Especially the latter effect is not uncontroversial. We have seen in many instances that gaming simulation decreased complexity in the P space for one specific part of the innovation but opened up a can of qualitative insights about other elements. This effect seems almost inherent to the use of gaming simulation, but if not expected by those who employ the method, the expansion of the P space will not be capitalized on. Expansions of P spaces, as we have seen, are only valuable when S and I spaces are either carefully designed beforehand or are similarly impacted by the game design process and the game itself. This provides additional challenges to the design of so-called exploratory gaming simulations as for to be valuable it is not solely about the design of the experiment but also about the design of the game design process, the session itself, and the debriefing.

Given the inherent tendency of gaming simulation to cause exploration, the debriefing becomes especially important for games that intend to cause convergence. We have seen that such gaming simulations led to divergence instead through a less structured debriefing. In light of this, the structured approach mentioned in Van den Hoogen et al. (2014) could be studied on its effect on bringing about convergence in solutions, perspectives, and actions.

References

Alkemade, F., Frenken, K., Hekkert, M. P., & Schwoon, M. (2009). A complex systems methodology to transition management. *Journal of Evolutionary Economics, 19*(4), 527–543.

Anderson, E. G., & Joglekar, N. R. (2012). *The innovation butterfly*. New York: Springer.

Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics, 1*(2), 93–118.

Cheng, Y. T., & Van de Ven, A. H. (1996). Learning the innovation journey: Order out of chaos? *Organization Science, 7*(6), 593–614.

Cooper, R. G. (2011). *Winning at new products*. Philadelphia: Basic Books.

Duke, R. D., & Geurts, J. (2004). *Policy games for strategic management*. Amsterdam: Dutch University Press.

Frenken, K. (2006). *Innovation, evolution and complexity theory*. Cheltenham: Edward Elgar Publishing.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy, 31*(8), 1257–1274.

Geels, F. W. (2005). Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. *Technological Forecasting and Social Change, 72*(6), 681–696.

Hekkert, M. P., Suurs, R. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change, 74*(4), 413–432.

Hoogma, R., Kemp, R., Schot, J., & Truffer, B. (2002). *Experimenting for sustainable transport: The approach of strategic niche management*. New York: Spon Press.

Kauffman, S. A. (1993). *The origins of order: Self organization and selection in evolution*. Oxford: Oxford University Press.

Klabbers, J. H. (2006). A framework for artifact assessment and theory testing. *Simulation & Gaming, 37*(2), 155–173.

Kriz, W. C., & Hense, J. U. (2006). Theory-oriented evaluation for the design of and research in gaming and simulation. *Simulation & Gaming, 37*(2), 268–283.

Meijer, S. A., Reich, Y., & Subrahmanian, E. (2014). The future of gaming for design of complex systems. In R. D. Duke & W. Kriz (Eds.), *Back to the future of gaming* (pp. 154–167). Bielefeld: Bertelsmann.

Rip, A., & Kemp, R. (1998). Technological change. In S. Rayner & E. L. Malone (Eds.), *Human choice and climate change* (pp. 327–399). Columbus: Battelle.

Van de Ven, A. H. (1986). Central problems in the management of innovation. *Management Science, 32*(5), 590–607.

Van den Hoogen, J., Lo, J. C., & Meijer, S. A. (2014). Debriefing in gaming simulation for research: opening the black box of the non-trivial machine to assess validity and reliability. In A. Tolk, S. D. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, & J. A. Miller (Eds.), *Proceedings of the 2014 winter simulation conference* (pp. 3503–3516). Piscataway, New Jersey: Institute of Electrical and Electronics Engineers.

A Feasibility Study of Land Readjustment Projects in Afghanistan by Developing and Applying Gaming Simulation

Ahmad Ramin Sadiq and Toshiyuki Kaneda

Abstract This paper outlines and analyzes key issues regarding the feasibility study of land readjustment (LR) in Afghanistan by developing a gaming simulation (GS). First of all, LR, its definition, its background, and application around the world is discussed, following which, the eminent domain, which is the current process in Afghanistan, is compared with LR, in order to highlight the efficiency and feasibility of LR in the current Afghan context. In a case study carried out in Shahrara, Kabul city's 10th district, necessary data was gathered and its current basic infrastructure, land uses, access to roads, primary schools, parks/open spaces, drainage systems, sewerage systems, parking areas, and drinking water supplies were analyzed. This paper, explores an Afghan model of LR in the case study area, by developing a GS tool, in order to improve stakeholder participation in different stages of a LR project. Game objectives, descriptions, roles, rules and timing, as well as results and findings will be discussed in this paper. At the conclusion of the paper, the following questions will be answered:

Is LR a feasible method to provide efficient basic infrastructure to urban Afghanistan?

- By understanding the mechanism of LR, what does an Afghan LR model look like?
- Can GS be a good tool for better participation of stakeholders in LR projects in Afghanistan?
- What processes are required to develop a GS for LR projects in Afghanistan?

Keywords Feasibility study • Land readjustment • Gaming simulation • Basic infrastructures • Afghanistan

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1 Research Background and Objectives

Afghanistan is the homeland of more than 29 million people (Turkstra and Popal 2010) and has endured more than three decades of civil war and conflict. Around 60–70 % of Afghanistan's urban areas have developed informally and require regularization (Turkstra and Popal 2010). Currently, Kabul, the capital city, is suffering from having to accommodate 57 % of the country's total urban population (UN Habitat 2014). This is shown by the rapid growth of population and a lack of adequate infrastructure, the chaotic development of the city, and the growth of unplanned housing and settlements.

To improve the current chaotic urbanization of Kabul City and to establish some degree of organization and infrastructure, one approach is the countrywide upgrading of informal settlements (Turkstra and Popal 2010), by increasing the involvement of communities through a participatory urban development process (UN Habitat 2014) using land readjustment (LR).

From such a perspective, this research is about discovering an Afghan way of community design and development and, first, concentrates on introducing LR projects and their feasibility in Afghanistan.

2 What Is a Land Readjustment Project?

There is no specific definition of LR in the literature that covers all aspects of this phrase. However, Larsson G. gave the following definition of LR:

> ...land readjustment can be an important tool for developing new land or re-organizing urban areas. The landowners collectively contribute land for streets and other public services, and build the required infrastructure wholly or partly by adapting existing boundaries to the new plan. The new building sites are distributed according to the value of inputs for an area. (as cited in Schrock 2012, p. 13)

The origin of LR is found more than 100 years ago in Germany and then in Japan; both countries by the end of the nineteenth century had developed LR far in advance of many western countries and successfully solved the provision of infrastructure facilities for the rapid growth of population and also for rural-urban migration (Yanase 2013).

In Japan, most residents involved in LR projects participated voluntarily, which was a key factor for the success of the country's urban development projects. In excess of 50 % of all Japan's urban development was carried out using the LR method (Hayashi 2002).

In LR projects, landowners and leaseholders contribute a specified percentage of their land for the provision of basic infrastructure and better utilization of their property. In return after completion of any LR project, land values rise and land use is much improved, but naturally the land area owned will be smaller than before. For example, a landowner, before application of an LR project, has a large plot with poor infrastructure and ineffective land use; after completion of the LR project, their plot will be reduced in area, but with a higher value and with an improvement of the basic infrastructure.

To help in our exploration, it is proposed to describe the main characteristics of LR which were applied in Japan.

- The infrastructure of the urban area can be comprehensively improved on a real basis.
- Residents of the project area can maintain their normal life.
- The owners defray the cost of development equitably and in return receive benefits equitably.
- No waste in land use is created.
- The land registration books, cadastral maps, street names, and numbers can be arranged in an orderly manner, clarifying the boundaries of ownership.
- The project is usually limited to the infrastructure of the urban area and does not include the direct improvement of buildings in the area.
- The project procedures are complex, and it takes time for owners of land and leaseholders to understand them (JICA, 1987b).

According to these characteristics, LR can be a useful tool of urbanization for developing countries, as it is a flexible tool for any cultural or environmental context.

2.1 Applicability of Land Readjustment in Afghanistan

In the Afghanistan's context, where most land has been developed informally (Turkstra and Popal 2010), there is a serious need for an orderly land reformation process. This process should have the flexibility to solve both current and future problems of informal and formal settlements. The participation and contribution of communities in this process are key factors in overcoming these challenges and problems. Community development through sharing resources, resolving conflicts, and working together is part of the traditional culture of Afghanistan (Turkstra and Popal 2010).

Currently, according to current legislation and the Ministry of Justice, Kabul Municipality (KM) has the power of an eminent domain and can expropriate private land for the purpose of road widening and public services. It means KM is the only governmental organization that is mandated in such cases to compensate people whose property is expropriated or relocate them to alternative sites (AKTC 2011).

In contrast to this legal authority, another reformation process can be LR. As previously stated, the characteristics of LR itself have the potential to answer the environmental, cultural, and economic needs of the Afghan people. In order to understand the effectiveness of both processes, eminent domain and LR, a comparison of both is shown in Table 1 below:

Table 1 Comparison of eminent domain and proposed LR in Afghanistan

Description	Current eminent domain system	Proposed LR system
Public participation in the project	No	Yes
Public contribution in the project	No	Yes
Self-financed projects	No	Yes
Considering the previous special layout of the neighborhood in the proposed project layout as follows:		
Location of mosques	Yes	Yes
Location of historical buildings	Yes	Yes
Sanitary and water lines	Yes	Yes
Electrical lines	Yes	Yes
Location of land boundaries	No	Yes
Location of buildings	No	Yes
Location and alignment of road network	No	Yes
Provision of the following basic infrastructures:		
Access to roads	Yes	Yes
Drainage systems	Yes	Yes
Access to parks and open spaces	Not always	Yes
Access to primary school	Not always	Yes
Sewer system and water supplies	Yes	Yes
Regularization of existing land shapes	No	Yes
Access to mosque	Yes	Yes
Adequate parking area	Not always	Yes
Reserved lands to fund the project	No	Yes
Compensation:		
Cash paid equivalent to estimated market rate	Yes	Yes, if a plot is too small
Relocation	Yes, to a different neighborhood	Yes, inside the neighborhood
Increased land value after project completion	Yes	Yes

Sources: AKTC 2011; Kabul Municipality Law 2007; JICA 1987a, b

As we can see in the chart above, as it covers more aspects of urban planning, LR yields more benefits than the current eminent domain method. Unlike the eminent domain method, LR projects are self-financed and allow for public participation and contribution. When considering many other factors of urban planning such as better accessibility to basic infrastructure inside a neighborhood, consideration of the previous spatial layout, lower compensation payments, and relocation to the nearest location inside the neighborhood, it is evident that the proposed LR will be more efficient across Afghanistan than the current eminent domain method.

2.2 Proposal for an Afghan Model of Land Readjustment

Just as the environmental, cultural, religious, and geographical needs of each country are different, each country and culture needs their own models of LR (Doebele 2002). For example, the US LR model is completely different from that of Turkey. Consequently, to successfully answer the needs of the Afghan people, this process recommends designing an Afghan model of LR specifically for Afghanistan, which needs to incorporate all those factors.

A key factor is to respect the religious and historical places in any project. The Afghan general public will never accept the relocation of mosques or shrine sites in their neighborhood. Other potential factors are the environmental indicators of the neighborhood: minimum residential land area; access to main/sub-roads, drainage systems, primary schools, mosques, parks and daily-use shops, water supplies, sewerage systems, parking areas, and contribution percentage rate; and settlement of legal status and land values.

3 Research Methodology

The core component of any LR project is the participation of residents. In order to increase the participation and involvement of stakeholders to thus help identify urban planning and environmental problems, and also give residents the chance to share with the local municipality their ideas and feedback in an open and democratic environment, it is necessary to find a tool and methods to support the participation of stakeholders in all stages of any LR project. The proposed methodology is the gaming simulation method, as it has many potential features to help clarify and increase resident understanding of all stages of any LR project and thus improve the quality of feedback.

3.1 Gaming Simulation

The term GS is a combination of two keywords, gaming and simulation. Before continuing, it is useful to briefly describe the definition of each keyword and then the definition of gaming simulation itself.

The term “game” has a long history. However, games are more difficult to define. Simply, they are sets of activities performed by groups of people where a set of rules or conventions constrains or defines the limits of activity (Greenblat and Duke 1981).

And simulation is an operation model of presentation (Greenblat and Duke 1981).

Now, according to Duke R.D.'s definition:

> Gaming simulation is a "Future's Language" a new form of communication emerging suddenly and with great impact across many lands in many problem situations. (Duke 1974)

GS can be used for many communication purposes or in problem solving situations, for instance, training, education, research, and social and business contexts. Principally, the use of GS in a social system is the same as with other uses. However, in all categories central features are identified, and then they are put together in such a way that they can be operated similarly to a real-world system.

There are reasons and rewards associated with the worldwide use of gaming simulation. As Greenblat C. S. and Duke R. D. stated in their book:

- The process of design in GS forces a greater clarity in thinking about critical elements.
- The design process forces a search for concreteness.
- To make the game work, social scientists must develop an overall systemic understanding of the topic.
- Once the model has been developed, then it can be readily experimented with and thus serves as a fruitful tool for exploration of theory (Greenblat and Duke 1981).

Besides the abovementioned rewards about GS, simulation itself has some valuable features and rewards like economy, visibility, reproducibility, and safety, which all enhance its potential as a problem solving and communication tool.

4 Development of Gaming Simulation in Case Study Area (District 10, Kabul)

GS deals fully or partly with players, who within the rules have their roles, goals, and activities to perform (Greenblat and Duke 1981). To know more about development of a GS, a survey was conducted in Shahrara, District 10, of Kabul City, where Kabul Municipality intends to introduce a pilot LR project. Therefore, first, the case study area is briefly introduced. Second, requirements and stages of GS design are reviewed. Third, the objectives, descriptions, roles, rules, and timing of the designed GS are described. Finally, a project exploration of the Afghan-designed LR through applying the GS was tested to check the viability of the designed GS.

4.1 Case Study Area Briefings

Currently, the Shahrara area is one of the highest valued areas in Kabul City, as it is close to Kabul Central Business District. In District 10, the selected section of Shahrara measures about 12.5 ha and contains a total of 160 plots of which 22 are

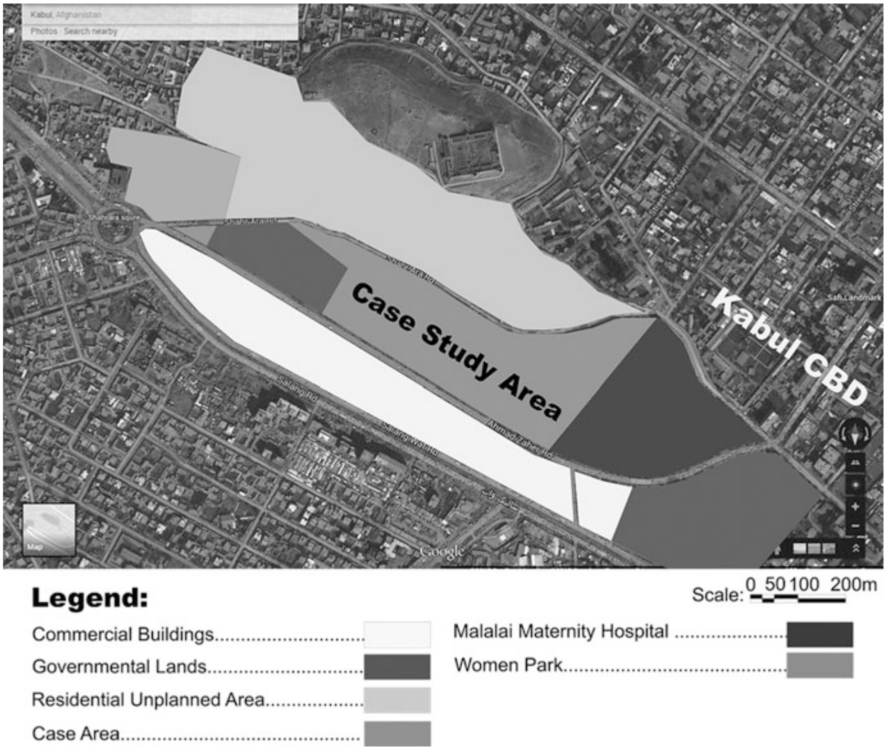

Fig. 1 Arial plan of the Shahr-Ara area (Drawn by Author, adapted from Google Maps, 2015)

commercial and 138 residential and include mosques and shrines. The residential section is home to 145 families and some 1,000 residents (Figs. 1 and 2).

The following are the main problems found in the case study area:

Plot sizes and shapes, ineffective land use, poor road network, no drainage system, no sewerage and water supply systems, only distant access to a primary school, and inadequate land area for mosques and parks.

4.2 Design of Gaming Simulation of a Land Readjustment Project

This game is designed to collect residents' ideas and comments on the proposed replotting design for an LR project in the case study area. In the preparation of the proposed replotting design in LR projects, the contribution rate is one of the key factors and can give direction to the designers concerning the exact areas needed to be allocated for different land uses.

Fig. 2 Current conditions of Shahr-Ara area's sub-roads (Photo by Author)

In countries where LR has already been adopted, LR laws stipulate the maximum contribution rate. As this is Afghanistan's first LR project, different contribution rates and land values will be calculated, and then the optimum land value will determine the contribution rate for the LR project in our case study area as follows:

1. Based on assumptions, nine environment indicators (the settlements legal status and land area, access to main/sub-roads, primary schools, mosques and parks, water supplies, sewerage systems, and parking areas) are listed to calculate the different land values according to their qualities. For effective use of time, 18 land plots were considered as representative examples of all plots.
2. Now to find the land values of different contributions, it was recommended to assess the minimum required land area for provision of basic infrastructure, and based on Ernst and Neufert Architect's Data and JICA's 1987 report, we calculated the required areas for a primary school, green/open space, and road networks.
3. Finally we compared the total contribution percentage of land area with the minimum required land needed for basic infrastructure. The result showed that a 25 % contribution would be required to provide the minimum area for provision of a basic infrastructure (primary school, park/open space, road network) in the proposed replotting design.

4.2.1 Game Objectives

As community participation is one of the main components in any LR project, the collection of resident ideas, comments, and feedback about the proposed replotting design is an essential part of the process. This usually takes around 2 months, depending on the size and limits of the project. In this game it is planned to decrease this time to 20 days, during which time the proposed plan will be displayed on-site and the residents' ideas and feedback will be collected through playing the game.

The result of this game will guide us how best to collect residents' ideas and comments about the proposed replotting design for the application of the LR project in the case study area.

It is proposed for this game to be played on a physical flexible model of our case study area. And it was assumed that only four landowners own all the land. Then, we divided the case study area into four different sections as shown in Figs. 3 and 4.

4.2.2 Game Roles, Timing, and Procedures

The following roles are suggested to play this game:

1. Landowner A
2. Landowner B
3. Landowner C
4. Landowner D
5. Designer of the LR from KM
   Total time for playing the game was 30 min as follows:

   - Ten minutes for introduction to the game (chair and players)
   - Fifteen minutes for playing the game (players)
   - Five minutes for discussion

   Steps of the game:

1. Players are selected, and each player is given a short explanatory text to read.
2. The present plotted area plan and proposed replotting plan are provided.
3. The location of land plots, parks, a primary school and road placement and direction on the proposed replotting plan can all be moved freely.
4. The two mosques and the shrine cannot be moved and are fixed on the proposed replotting plan.
5. The KM representative will start a discussion about the proposed plan and invite landowners to share their ideas and concerns. Landowners can modify the locations of parks, the primary school, and roads based on the game rules, but only within the proposed replotting design. Any such revisions can be incorporated into the flexible model.

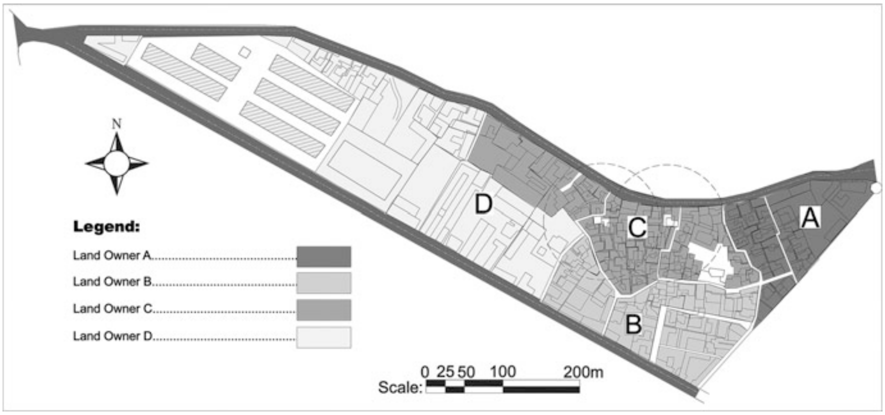

Fig. 3 Shahr-Ara existing plotted area (Drawn by Author, adapted from Bing maps, 2015)

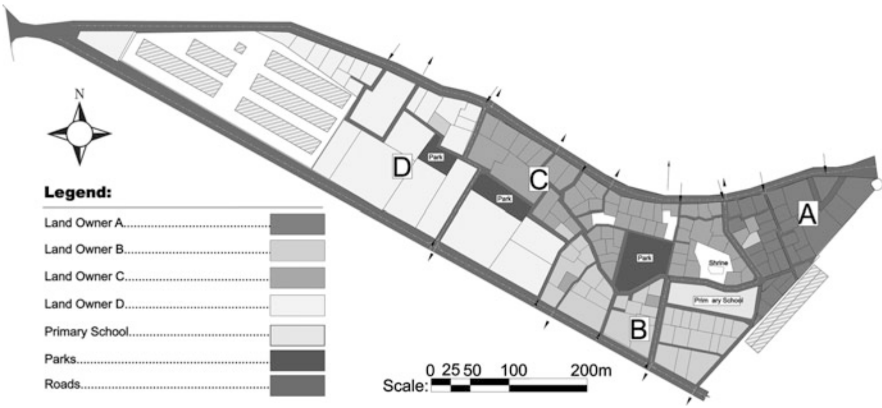

Fig. 4 Proposed replotting design (By Author)

6. Finally, the proposed ideas and revisions of the landowners are finalized, and the overall scheme of the area will be provided for the preparation of the final replotting design of the LR project.

4.2.3 Game Rules

For the current land prices for informal and formal lands, we use the AKTC's report, Kabul Urbanization and Development Challenges 2011; for minimum residential land area, we use JICA's supplementary report for Kabul City Master Plan 2011; and other game rules are assumption based.

5 Project Exploration of Afghan's Own Land Readjustment Through Applying Gaming Simulation

To ensure the viability of the designed GS, a project exploration of the Afghan-developed LR by applying the GS was tested. For this purpose we invited master and doctoral course students from Nagoya Institute of Technology to run this test play.

Fortunately, all of the players in our project were from Afghanistan with an overall image about our case study area. The model of our case study area was printed on A3-sized paper to a scale of 1:2,000. Inside the model, five to ten land plots were divided into clusters for relocation. A conceptual model for school presentation and three conceptual tree models were created to represent the landscape areas.

At the start of the game, all players were thinking about the game concept. After introduction to the game, all players understood the game objectives, procedures, player responsibilities, game rules, and the model of our case study area.

As shown in Fig. 5, everyone played their role actively and the game was played to a successful conclusion.

As shown in Fig. 6, players carried out their revisions and modification on the model of our case study area according to the game rules. Finally, a modified version of a proposed replotting design was produced by our players. Then we had a 5 min discussion about the overall concept and performance of our project with our players. They gave us some valuable feedback and proposals for improving and enriching the designed GS as follows:

- More time at each stage of the game is required; 45 min or 60 min would be much better.
- Enlarging the scale of the model to 1:1,000 or 1:500 would provide a clearer and more real sense of the game purpose during play.
- To control the model's consistency, using low magnetic materials for the base part, as well as the land plots and other elements, would be helpful for ease of play.

6 Results and Findings

One of the main goals of this study was to explore GS as a tool for LR projects in Afghanistan. In the project results we found, the project exploration of an Afghan LR through applying GS was interesting and effective for all players. Players understood the overall mechanism of the LR project and also the game's introduction, objective, procedures, and rules. The roles were realistic and players soon grasped what activities can bring them more benefits. There was too little time allocated, especially for the introduction. The actual physical case study model was

Fig. 5 Performing the LR project by applying GS

a little too small in scale, resulting in the occasional disarrangement of relocated pieces during play.

In the developed GS, there were some assumption-based items, for instance, determination of the contribution rate with environmental quality indicators and most of the game rules; this needs serious attention by researchers and scholars in the future to propose more comprehensive and applicable methods for developing and applying GS for LR projects in Afghanistan.

The three key findings of this study are the following:

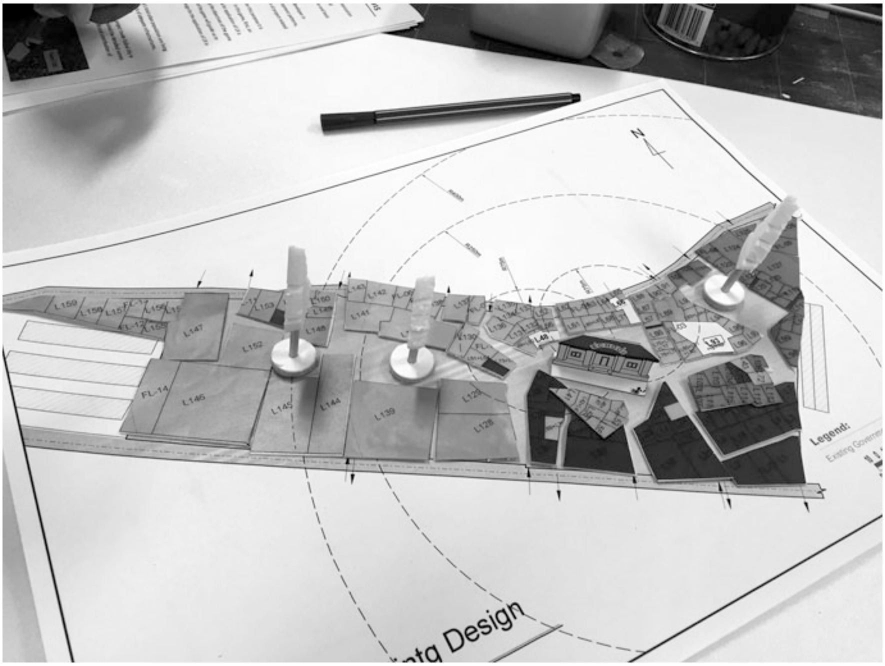

Fig. 6 Final modified model after applying GS for the LR project

1. Based on an efficiency comparison between the LR and eminent domain processes in Afghanistan, we found LR to be an effective method for an Afghan way of community design and development.
2. As discussed, each country needs its own model of LR. Hence, an Afghan model of LR was defined. Then, in the case study a project exploration of Afghan's own LR through applying GS was studied and analyzed. So, we found that country-wide applications of LR projects need a comprehensive national definition of the Afghan LR model and LR law by KM.
3. As stated in any LR project, participation of stakeholders, especially residents, is an essential component. Therefore, the requirements for a tool and method to support this process in LR projects were explained. And essentially we found that GS has powerful features that can increase and support community involvement at all stages of an LR project.

7 Conclusion

The majority of this research was focused on a feasibility study of LR projects in Afghanistan by developing and applying GS. Valuable lessons can be drawn, as a result of comparing LR with the current eminent domain process; LR is an efficient and feasible process for Afghanistan.

As shown by the conducted survey, a specific structure for development of GS was identified. Finally project exploration of an Afghan LR through applying GS was studied and analyzed. Then, it was proved that GS as a tool for LR projects is a strong and useful method to enhance the involvement of stakeholders in LR projects in Afghanistan.

As a final conclusion, while LR is clearly a useful land reformation process to develop an Afghan way of community design and development, the proposed Afghan model of LR needs nationwide definition by establishment of comprehensive LR legislation by KM.

References

AKTC, Agha Khan Trust for Culture (2011). *Kabul urbanization and development challenges*. United States Agency for International Development, USAID.

Doebele, W. A. (2002). *Introductory remarks, conference paper in land readjustment workshop at Lincoln Institute of Land Policy*. Cambridge, MA, USA

Duke, R. D. (1974). *Gaming: The future's language*. England: Sage.

Greenblat, C. S., & Duke, R. D. (1981). *Principles and practices of gaming simulation*. London: Sage.

Hayashi, K. (2002). *Land readjustment as a crucial tool for urban development*, *conference paper in land readjustment workshop at Lincoln Institute of Land Policy*. Cambridge, MA.

JICA, Japan International Cooperation Agency. (1987). *City planning in Japan* (Vol. I). Japan.

JICA, Japan International Cooperation Agency. (1987). *Textbook for the group training course in housing*. Japan.

Kabul Municipality Law. (2007). Kabul.

Schrock, M. (2012). *The potential use of land readjustment as an urban redevelopment strategy in the United States: Assessing net economic value* (Master's dissertation). Massachusetts Institute of Technology, USA.

Turkstra, & Popal. (2010). *Peace building in Afghanistan through settlement regularization. 46th ISOCARP Congress*, Nairobi.

UN Habitat. (2014). *Afghanistan's urban future. Discussion papers #01 and #02.*

Yanase, N. (2013). *Understanding Kukaku-Seiri (land readjustment), conference paper on JICA's urban development course*. Japan.

Development of SASKE-NABLE: A Simulation Game Utilizing Lessons from the Great East Japan Earthquake

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Abstract After the Great East Japan earthquake, disaster management measures put priority on constructing large-scale evacuation centers in Fukushima, including the BIG PALETTE FUKUSHIMA. The unpredictable and widespread calamity made staffs of the evacuation center run into difficulty in assisting evacuees. Due to the national standard of the evacuation center's operation, the staffs were trained to comply with management manuals that were, to some extent, not applicable and responsive to evacuees' needs. Hence, the use of individual expertise and collective experiences in emergency management played an important role to keep the evacuation center functioning efficiently and effectively.

The lesson learned from evacuation-center management was translated to the design of "SASKE-NABLE," a simulation game based on decision-making principles. With the concern on happiness of evacuees, this simulation game aimed at making stakeholders, who would be involved in evacuation-center management, understand a social dilemma often happening in operating evacuation centers while highlighting a significance of flexible management based on staff's life experience.

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Results from utilizing this game with the participants suggested that SASKENABLE could cultivate participants' awareness on evacuation-center management, reflect on the essential roles of each participant in the management, and facilitate the collective decision-making process in order to produce solutions that may prompt action. As a result, this game can be regarded as a training-for-trainer tool.

Keywords Large-scale evacuation centers in widespread disaster • Evacuation-center management • A training-for-trainer tool

1 Introduction

A number of large-scale evacuation centers were immediately set up in Fukushima Prefecture after the Great East Japan earthquake in 2011. Because of the unpredictable and widespread disaster, the evacuation center staffs find it difficult to assist the evacuees and operate in the center efficiently.

BIG PALETTE FUKUSHIMA evacuation center operated by Kazuhiko Amano and his team was regarded as the biggest evacuation place with 2,500 evacuees and 5 months of the operation. The staffs in this center, therefore, faced difficulties in the evacuation-center management through trial and error by making the best use of individual life experiences to support evacuees during disaster evacuation and recovery processes (Fig. 1).[1]

After the Great East Japan earthquake, Central Disaster Prevention Council produced a report on the possible damage caused by the impacts of Tokyo earthquake and Nankai Trough earthquake (Table 1).

Those estimations were based on a worst case. Even though the catastrophic losses might be smaller than the worst case, many large-scale evacuation centers will be established. The situations in the center might be as serious as the Fukushima case.

Central Disaster Management Council of Japan (2013c) summarized that evacuees were facing a lack of emergency supply, physical/mental depression, and exacerbation of chronic diseases, which could lead to a second disaster – death – in evacuation centers. The summary of the Central Disaster Prevention Council was not intended to be comprehensive. In fact, several social conflicts are involved. Deteriorated health and mental-related quality of life and capabilities of individual evacuees for rehabilitation occasionally catalyze the social conflicts in an evacuation center. For example, vulnerable people such as aged persons, handicapped persons, pregnant women, family with babies, and foreigners were sometimes excluded from evacuation centers of the Great East Japan earthquake (a report of Cabinet Office of Japan (2015)).

[1] BIG PALETTE FUKUSHIMA evacuation center has a good lesson learned from the Great East Japan Earthquake introduced in a number of reports. Cf. Government of Japan and World Bank (2012).

Fig. 1 Shelter management in BIG PALETTE FUKUSHIMA evacuation center (Source: one of the staffs of BIG PALETTE FUKUSHIMA)

Table 1 Outline of expected megaquake in Japan

Earthquake	Tokyo earthquake	Nankai Trough earthquake
Damaged site	Tokyo metropolitan area	Pacific coastal prefectures
Magnitude	M 7.3	M 9.1
Dead/missing person	23,000	332,000
Evacuees	3,390,000 (1 day after)	7,200,000 (2 week after)

Source: Central Disaster Management Council of Japan (2012, 2013a, b)

Similarly, World Bank (2012) pointed out that the lack of considerations for gender made evacuation life of women miserable.

To solve those problems, the concept of "Humanistic Evacuation Center Management" was proposed by World Bank (2012). This kind of management suggested future evacuation-center staffs to consider the diversity of evacuees and their needs, the essential of communication with/among evacuees, the evacuee involvement in the evacuation-center management, and the flexible management and responsive decision-making process such as a case of BIG PALETTE FUKUSHIMA. Based on the lesson learned from evacuation centers in Fukushima, a decision-making simulation game, "SASKE-NABLE[2]," is designed for evacuation-center management staffs to understand real problems of evacuation-

[2] SASKE-NABLE is a combination word between "sustainable" and "sasuke-nae" (dialect of Fukushima area that means no problem/never mind).

center management and to perform flexible management, placing priority on the happiness of evacuees through the use of staff's life experience.

2 Outline of SASKE-NABLE

2.1 Aims and Targets

The aims of SASKE-NABLE can be divided into four main issues as follows:

1. Cultivating participants' awareness on management problems of large-scale evacuation center and conceptualizing their mind to cope with the problematic situations as staffs of the evacuation center.
2. Promoting participants' roles in the evacuation-center management, which is not to control the evacuees, but to facilitate in the center with respect for human rights and to keep the happiness of diverse evacuees.
3. Motivating participants to concern that many unexpected conflicts/troubles will be occurring in the evacuation center and promoting experiences and lesson learned from their own lives, instead of strictly relying on preset instructions in a manual.
4. Making participants understand that the following strategies are useful for the evacuation-center management:
   (a) The accurate perception in individual capabilities and difficulties of evacuees
   (b) The spiritual openness, listening to evacuees' voice to improve their living environment
   (c) A common space of evacuees to communicate
   (d) A self-governing organization of evacuees to be part of the management
   (e) Networks of local specialized agencies and civil organizations to address difficulties of the center

2.2 Meta Level and Game Level (Table 2)

The above table is a matrix of Meta Level and Gaming Level aspects of SASKE-NABLE. Meta Level refers to conditions and phenomenon that happen in reality, while Game Level intends to abstract that reality and translate it into the game.

The comparison between Meta Level and Gaming Level leads to constructing a conceptual framework of SASKE-NABLE.

Main targets of the game ("Who" in Game Level) are people who would be engaged in the management of evacuation centers, namely, specialized staff of evacuation centers, local government officers, social welfare council staffs, NPO of

Table 2 Compares between Meta Level and Game Level

Meta Level		Game Level
Period of opening evacuation center (immediately after disaster until around 1 year past)	**When**	Training program for evacuation-center management
		Lecture class of disaster mitigation
Evacuation center in damaged site	**Where**	Training place
		School, university
Local government officers	**Who**	Local government officers
Social welfare councils staff,		Social welfare councils staff
NPO		NPO
Facility managers of evacuation centers		Facility managers of evacuation centers
Community leader		Community leader
		Students
Coping with various conflicts and trouble in evacuation center	**What**	Making solution about trouble cases based on real stories in the evacuation center after the Greatest Japan earthquake
Decision-making among staffs, with evacuees and implement	**How**	Decision-making among other participants

emergency support, facility managers of evacuation centers, and a community leader. Those people are potential staffs in operating evacuation enters when disaster happens in reality ("Who" in Meta Level). In addition, SASKE-NABLE also intends to train students, especially junior high school students, high school students, and university students, as evacuation-center staffs in the future.

"Where" in Mate Level is at the evacuation center and "When" in Meta Level is the period of opening the evacuation center immediately after the disaster occurs until the recovery process is concluded. Alternatively, "When" and "Where" in Game Level is when we launch a training program for evacuation-center management or a disaster mitigation lecture/class at school.

In real situation, evacuation staffs possibly ran into trouble early on, when an evacuation center is operated ("What" in Meta Level). To translate this experience into the game, participants were asked to take cards with the description of real troublesome cases in the evacuation centers in Fukushima Prefecture after the Great East Japan earthquake, and then they tried to make solutions for the given situations ("What" in Game Level).

In reality, staffs have to make a decision on solving unexpected conflicts/ problems under vigorous discussion ("How" in Meta Level). This phase was put into the game in order to let participants get experience in decision-making process, which reflect their roles in managing the evacuation center ("How" in Game Level).

2.3 Style of the Game

SASKE-NABLE is a workshop-style game based on the collective discussion on making solutions for various kinds of problems occurring at an evacuation center. The game "SASKE-NABLE" offers 15 critical issues for the discussion. Three or 4 out of the 15 cards will be selected by the facilitator in each gaming session.

According to the 15 critical issues, every issue was based on the real cases of evacuation centers in Fukushima Prefecture that were based on interview with evacuation-center staffs and experiences of the authors themselves.[3]

3 Verification of the Effects

3.1 Outline of Trial Gaming Session

This trial gaming session aimed to verify impacts of the game based on two points:

1. Promoting participants' roles in the evacuation-center management, which is not to control the evacuees, but to facilitate in the center with respect for human rights and to keep the happiness of diverse evacuees
2. Motivating participants to concern that many unexpected conflicts/troubles will be occurring in the evacuation center and promoting experiences and lesson learned from their own lives, instead of strictly relying on preset instructions in a manual.

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[3] We are collecting problematic issues of the evacuation-center management with the hope to increase the numbers of situations that we put into the game.

In BIG PALETTE case, some evacuees got many newspaper to deliver to other evacuees who are handicapped and have difficulty in walking to get newspaper. Amano, the second author of this paper, knew this situation from "newspaper delivery men," and he divided the evacuation center to several sub-districts, and then he asked them to be "formal newspaper men" to solve conflicts and to promote self-governance based on evacuees' involvement

This is a real story at governmental facilities that became an evacuation center in Fukushima. Finally the government changed the chief and decided to allow evacuees to use shower rooms. But this conflict was regarded as a barrier of trust building between staffs of evacuation center and evacuees for several days

This situation is a typical repressive situation of every evacuation center. Leaders of evacuation centers are almost male, and they tend to be difficult to notice this issue

In the case of BIG PALETTE FUKUSHIMA, the leader defined a specific space for women quickly after getting complaints, and information about this space is given only in women's toilet to keep it secretly from male evacuees for security reasons

This space was regarded as a common space for networking among women. This space allows woman evacuees to express their hidden needs. This place also serves as the incubation of self-governance of women themselves.

Table 3 Outline of the trial gaming session

Date	24 Feb, 2015
Place	Muroto Nature Hostel, Muroto City, Kochi, Japan
Participants	23 persons (20 staffs, including 3 females and 3 male students of Kochi University)
Scenario in the game	**When:** Three weeks after Nankai Trough earthquake, the campus of Kochi University becomes an evacuation center for 3,000 evacuees
	Role of participants: University staffs who become staffs of evacuation-center management

The trial gaming session was held on Feb 24, 2015, at Muroto Nature Hostel, Muroto City, Kochi Prefecture, Japan. Otsuki S. was the facilitator of this trial session.

The participants were staffs of Kochi University, a governmental university of Kochi Prefecture. This prefecture is located along the pacific coastal zone that was expected to face the catastrophic damage caused by Nankai Trough earthquake. Kochi University Campus is expected to be a large-scale evacuation center. Nevertheless, university staffs, who are supposed to be the evacuation-center staffs when the university campus becomes one of the evacuation centers, almost do not have recognition for this situation (Table 3).

In this session, a scenario that 3 weeks after Nankai Trough earthquake and Kochi University Campus becomes an evacuation center for 3,000 evacuees was put in the beginning of the game. In order to let participants imagine what could happen afterwards, roles of evacuation-center staffs were given to 23 participants: 17 were male staffs, 3 were female staffs, and 3 were university students. Those participants were divided into five groups (Table 4).

3.2 Procedures (Fig. 2)

The gaming session were divided into four parts.

The first part was "briefing parts" of the game. The scenarios, rules, roles, and process of the game were explained during this part.

The second part was "practice part." After the participants were giving the roles, the facilitator raised issues about conflicts/problems in an evacuation center. The participant groups tried to discuss and make a decision on suitable solutions. Each participant filled solutions and reasons into the paper, and then, participants had to discuss in order to make a decision in each group. After the decision-making in the groups, each group had small presentation about solution and reason, and finally each participant voted the best solution (exclude their own team solution). A team that got the most voting score got points. After that, the facilitator gave the participants five strategies of the successful evacuation-center management, which were a lesson learned from Fukushima.

Table 4 Outline of the participants' groups

Group A	Group B	Group C	Group D	Group E
A Chief of administrative section (female)	A staff of administrative section	A Chief of administrative department	Three administrative section	A staff of administrative section
A Vice Chief of administrative department	Three staffs of nonadministrative section	Two staffs of nonadministrative section	A student	Two staffs of nonadministrative section
Three staffs of nonadministrative section	A student	A staff of nonadministrative section (female)		A staff of nonadministrative section (female)
A Student		A Student		

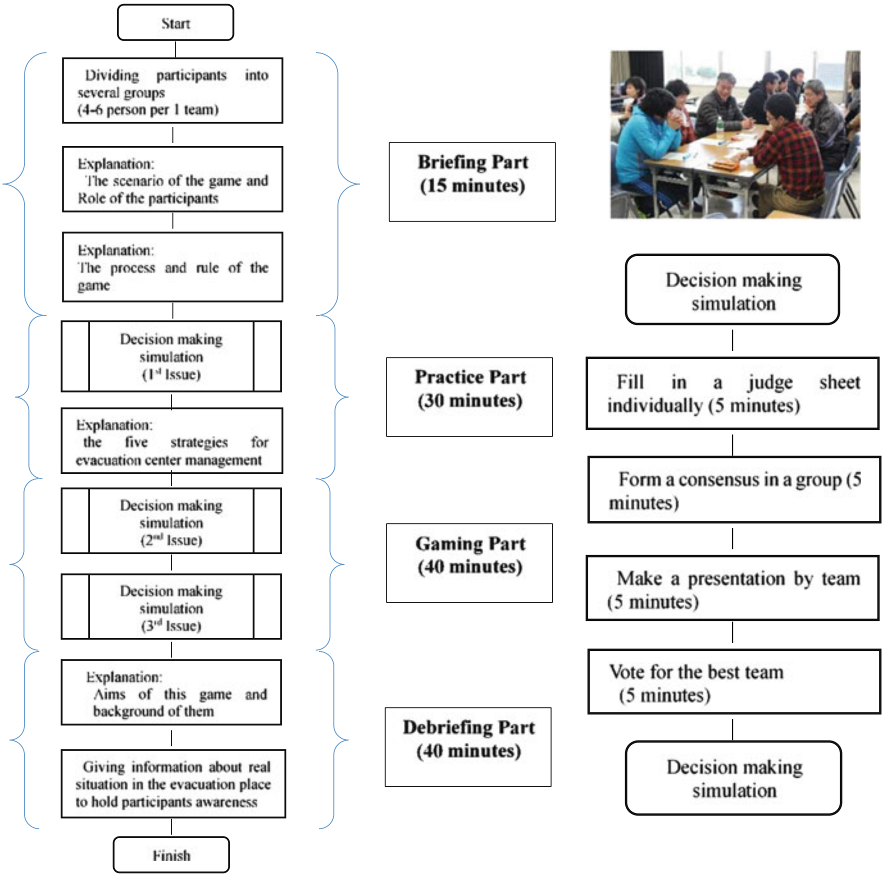

Fig. 2 Flowcharts of the game

After the practice, a third part (gaming part) offered the participants to play the game with another two or three problematic and dilemma issues, which were selected by the facilitator. The decision-making and voting were as mechanics of the game as the second part. A team that got the highest points won a game.

The last part of the game ended with "debriefing" to explain aims and background of this game and to give information about real situations in the evacuation center, in order to enhance participant's awareness.

Table 5 Results of first issue

The Men called "Newspaper Delivery" The amount of newspaper in the evacuation center was enough, but some evacuees could not get them. Some evacuees complain the staffs that some evacuees pick many papers. Finally, trouble among evacuees happens, and some of them got injury.				
Group A	Group B	Group C	Group D	Group E
Stop delivering to express decisive stance for control evacuation center	-Listen reason first to make solutions	Make list for evacuees who need newspapers	-Making group in each sub area and give role to distribute newspaper -Listen reason first	-Making group in each sub area and d give role to distribute newspaper

3.3 *Analysis of the Effects*

During the trial session, every idea from each group was recorded. Besides, survey questionnaire to be answered freely was implemented to every participant after the trial session. Those data were analyzed in order to verify the impacts of the game.

3.3.1 Expected Effect (1)

Promoting participants' roles in the evacuation-center management, which is not to control the evacuees, but to facilitate in the center with respect for human rights and to keep the happiness of diverse evacuees (Table 5).

In First issue, three groups' ideas were considered with various evacuees, importance of communication to getting evacuees needs, and promote a self-governing of evacuees, such as attentive hearing and grouping to promote governing evacuees selves.

But, "group A," which has two administrative position staffs who actually have roles in evacuation-center management in emergency, expressed repressive opinions to control evacuees such as "Stop to distribute newspaper to express decisive stance for control society of evacuation center."

After the presentation of each group, every participant voted which idea of the groups was the best one to cope with the defined situation. As a result of voting, the idea of the administrative groups (group A) was rejected as a second worst. An Idea of group D that had a consideration on diverse evacuees, the communication to getting evacuees needs, and a self-governing of evacuees was selected.

Table 6 Results of the second issue

Shower room is not allowed to use for evacuees?				
Evacuees were eager to take shower, and the evacuees knew that university has another available shower rooms. However, the chief of facilities administration division does not allow using it. He said only "Those shower rooms are not for evacuees according to our evacuation manual made before the earthquake". Consequently, the evacuees reach the limit of their patience.				
Group A	Group B	Group C	Group D	Group E
Instead of shower, provide room for wiping body.	-Make rule to use shower for under-standing of the chief, -Make role to keep clean the shower room by evacuees themselves. -negotiation with the chief,	-Make rule to use shower for under-standing of the chief, -Make role to -keep clean the shower room by evacuees themselves.	-Make rule to use shower for understanding of the chief.	-Make rule to use shower for under-standing of the chief, -Negotiation with the chief and get sympathy to change decision.

After the voting, the facilitator suggested to the participants that the mission of evacuation-center staffs was not to control the evacuees, but to make solutions and to respect and keep human rights and happiness of various evacuees(Table 6).

Regarding the second issue, administrative groups (group A) continued to take decision based on the administrative regulations over evacuees' quality of life. The idea rigidly complaining with the regulation was a worst decision based on the majority of participants (Table 7).

However, regarding the third issue, administrative groups changed their idea and took a decision that was more considered various evacuees, communication to getting needs, and self-governing of evacuees.

Through the game session, participants expressed their awareness by freely answering survey questionnaire after trial gaming.

After playing the game, participants expressed their awareness by answering open-ended questions. The main significant expression can be categorized into four aspects as follows:

– Before playing this game, evacuees had to bear with inconvenience and suffering feeling due to the staffs had to comply with the standard and regulation. The participants realized that keeping evacuees' happiness is also their mission as evacuation-center staffs.
– The participants were surprised that evacuees asked the staffs various things.
– The participants raise the awareness that the evacuation-center manager has to promote evacuees' involvement in the management as aspect of self-governance.

Table 7 Results of the second and the third issues

We are ashamed in everyday!
Complains from women

One day some women complain to the leader of the evacuation center strongly. "We are ashamed!! You know? We do not have any places to changing clothes" Additionally, women worry about using the toilet in the night, because (they feel) some suspicious men could watch them secretly when they are taking off their clothes.

Lack of underwear and sanitary goods is a serious problem for women, but they hesitate to express and ask for the improvement to staffs who are mostly male.

Group A	Group B	Group C	Group D	Group E
-Not only women room but also men room. (women do not need to consider about behavior of men) -Manager of the room should be women staff who understands what women want	-Room for women only, -Manager of the room should be women staff who understands what women want	-Not only women room but also men room. (women do not need to consider about behavior of men) -Put a partition in front of the toilet is not a reasonable way because it could increase risk of harassment from suspicious persons	-Hearing by women staff to grasp background of the complains, -Room for women only	-Not only women room but also men room. (women do not need to consider about behavior of men) -Put a partition in front of the toilet to keep privacy, then prepare items for women there such as sanitary goods,

– The participants finally thought that talking to the evacuees and hearing them are ultimately important for the responsive evacuation-center management.

The above aspects suggested that SASKE-NABLE game had a significant impact to enhance participant's awareness that the mission of evacuation-center management was not to control the evacuees but to make suitable solutions and respect human rights and keep the happiness of various evacuees.

3.3.2 Expected Effect (2)

Motivating participants to concern that many unexpected conflicts/troubles will be occurring in the evacuation center and promoting experiences and lesson learned from their own lives, instead of strictly relying on preset instructions in a manual.

Based on the observation during the game, most of the participants could make solutions and help in the evacuation-center management, based on their own experience, when they face unexpected situations. Noticeably, after the facilitators gave suggestion and comments on the ultimate mission as an evacuation-center

Table 8 Results of the second issue (re-thinking)

We are ashamed in everyday!
Complains from women

One day some women complain to the leader of the evacuation center strongly. "We are ashamed!! You know? We do not have any places to changing clothes" Additionally, women worry about using the toilet in the night, because (they feel) some suspicious men could watch them secretly when they are taking off their clothes.
Lack of underwear and sanitary goods is a serious problem for women, but they hesitate to express and ask for the improvement to staffs who are mostly male.

Group A	Group B	Group C	Group D	Group E
-Not only women room but also men's room. (women do not need to consider about behavior of men) -Manager of the room should be women staff to get hidden needs of women	-Room for women only, -Manager of the room should be women staff to get hidden needs of women	-Not only women room but also men's room. (women do not need to consider about behavior of men) -Put Partition in front of the toilet is not correct way because it makes risk of harassment from suspicious person (In toilet or rom for women is better)	-Hearing by women staff to grasp background of the complains, -Room for women only	-Not only women room but also men's room. (women do not need to consider about behavior of men) -Put Partition in front of the toilet to keep privacy, then put items for women there such as sanitary goods,

Discussion between two groups and create better idea

staffs, a number of participants express a variety of idea to solve the given problems, based on their experience (Table 8).

When we asked the participants to rethink about one of the situations given previously, the participants identified various alternatives based on the experience of women participants: for instance, separating critical rooms between woman and man, distributing specific items for women's needs in a private manner, and promoting women networks that can support women's needs.

In distributing women's items such as sanitary pads, the discussion among women participants led to the creation of better ideas for improving the responsive management of evacuation centers.

Through the above process, participants expressed awareness by freely answering survey questionnaire after trial gaming.

– The participants felt that staffs should not only follow a manual but also think deeply and make a reasonable decision that is the best for each evacuee.
– The participants mentioned, "Solutions in Fukushima were good but some ideas from other participants are also good, then I think that "perfect solution" is

nothing, but we should make a decision based on the rich communication between evacuees and other staffs."
– The participants found that they could highlight a sense of women's need to the disaster mitigation and evacuation-center management strongly.
– The participants found that one of their strong points in the evacuation-center management is their consideration about the diversity of evacuees and empathy for evacuees' situations.

As mentioned above, it is clear that SASKE-NABLE game has an impact on participant's awareness to consider the quality of life of the evacuee, instead of rigidly relying on the regulations of the evacuation-center management. Therefore, the participatory decision-making is necessary.

4 Conclusion

The starting point of developing SASKE-NABLE was the author's thought that painful experiences of the evacuation-center management in Fukushima and other centers shall be disseminated and put as a lesson learned for improving future disaster emergency management. This game aims to share and transfer the lesson learned from the evacuation centers in Fukushima to other places that are expected to face catastrophic events such as Tokyo earthquake and Nankai Trough earthquake. In addition, it intends to alter staffs' behavior and ideas in the management of evacuation centers.

A trial game session suggested that SASKE-NABLE game could enhance participants' awareness for the management of evacuation centers. By this simulated game, the participants had learned and experienced the difficulty of decision-making and the importance of their life experience to think about optimized solutions. The participants gave feedbacks to the facilitators that this game has its own strong points, which are as follows:

1. True story awakens participants' interest in active participatory decision-making processes.
2. Participants could repeatedly get vicarious experiences of some unexpected conflicts/trouble, which make participants aware about diversity of opinions/ solutions.

Additionally, comments of participants suggested that opened discussions in the game gave an opportunity to take the cross-sectional and inter-age networks among participants, which are most important to **operate the evacuation center smoothly.**

From those points of view, SASKE-NABLE game can be regarded as an educational tool to share and transfer a lesson learned from Fukushima to other places. Nevertheless, there are four considerable issues influencing the efficiency and effectiveness of this game:

1. Development of the reflection method and its insertion into the debriefing part; reflection process is needed in debriefing part, and this program could cultivate participants' awareness and alter their behavior.
2. Rearrangement of the time allocation of the game to enhance enough discussion time among the participants.
3. Putting more strategies (into the process of game design) which allow participants to discuss and enhance awareness deeply, such as adding of role of evacuees who have complain to staffs or has hidden needs of evacuees, adding the opportunity for the discussion across groups.
4. Reconsideration order of the five strategies for the successful evacuation-center management by the facilitator in order to raise awareness of participants, such as explanation given only at debriefing parts.

References

Cabinet Office of Japan. (2015). *The guideline for keeping good living conditions in evacuation center*. Cabinet office of Japan. http://www.bousai.go.jp/taisaku/hinanjo/h25/pdf/kankyoukakuho-honbun.pdf

Central Disaster Management Council of Japan (2012). *Nankai Trough earthquake damage estimation* (1st report).

Central Disaster Management Council of Japan (2013a). *Nankai Trough earthquake damage estimation* (2nd report).

Central Disaster Management Council, Japan. (2013b). *Estimation of earthquake that directly hits Tokyo area and coping*. Cabinet Office, Japan. http://www.bousai.go.jp/jishin/syuto/taisaku_wg/pdf/syuto_wg_report.pdf

Central Disaster Management Council of Japan (2013c). *A guideline for keeping good environment in evacuation center*.

Government of Japan & The World Bank Institution. (2012). *Knowledge note*. The World Bank. http://siteresources.worldbank.org/JAPANINJAPANESEEXT/Resources/515497-1349161964494/J3-5EvacuationCenterManagement.pdf

Publishing committee for chronicle of Big Palette Fukushima evacuation center (2011). be alive and continue to be alive -chronicle of Big Palette Fukushima evacuation center -. Publishing committee for chronicle of Big Palette Fukushima evacuation center.

A Simulation of Economic Loss Impact and Recovery: A Case Study of Shima City Assuming Nankai Trough Earthquake

Mingji Cui, Hitoshi Taniguchi, Yusuke Toyoda, and Hidehiko Kanegae

Abstract According to Sendai Framework for Disaster Risk Reduction (DRR) 2015–2030, understanding disaster risk not only in hazards but also in impacts of economic growth is considered as an important process of DRR activities and disaster preventions. There are several previous researches on proposing estimation methods of disaster damage, and the models in these researches are of great value to predict the damage of Nankai Trough earthquake. However, they have not considered about the effects of population change on economic damage and recovery. This study expends previous estimation models of the abovementioned and develops a simulation model of economic recovery process that incorporates the population variation amount. Specifically, focusing on the damage of private sector enterprises and population outflow from the disaster-stricken areas, it proposes the time-series recovery process model of regional economy and applies to a coastal city Shima in Mie Prefecture, Japan, and examines the economic recovery process and the damage and losses by using the Nankai Trough earthquake in 2030 as a hypothesis.

1 Introduction

The Third UN World Conference on Disaster Risk Reduction (WCDRR) in March 2015 adopted Sendai Framework for DRR 2015–2030 (UNISDR 2015). It stated the global targets which were the reduction of disaster mortality, the number of

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affected people, and also the disaster economic loss related to global gross domestic product (GDP) by 2030. Moreover, identifying disaster risks in the medium and long term was specified as among the roles of stockholders and academia, scientific, and research entities. Understanding disaster risk not only in hazards but also in impacts of economic growth is considered as an important process of DRR activities and disaster preventions.

In recent years, large-scale disasters such as earthquake, tsunami, and flooding have been occurring frequently around the world. The data from the International Disaster Database (EM-DAT 2015) shows there have been a trending down of human damages but a substantial increase in the amount of economic damages. The economic loss from the Great East Japan earthquake in 2011 amounted to anywhere between 23 trillion yen and 26 trillion yen which exceeded the damage recorded by the Great Hanshin earthquake (about 10 trillion yen) in 1995. Such huge financial damage is projected to be a cause for substantial impact onto the social-economic environment such as the damage of social infrastructure and dire living situation of residents, as well as the decline in economic activity.

In particular, with its declining population, falling birthrate and aging population, decreasing number of workers, and changes in social-economic structure are expected in Japan and will cause challenges in the recovery of regional vitality and reconstruction efforts in economic activities post disaster. In addition, as it has been witnessed in the cases of the Great Hanshin earthquake and the Great East Japan earthquake, the decline in consumption activities or the bankruptcy of regional finances due to the population outflow from disaster-stricken areas will cause further depression of regional economies.

Hence, reconstructing buildings, infrastructure, etc., requires 2 or 3 years (short term), whereas recovery of regional economy needs 10 or 20 years (long term). In order to be prepared for future mega disasters, it is necessary to reconsider the disaster risks not only in the medium term but also in the long term and analyze the economic recovery process by taking these economic factors into consideration. It is also imperative to provide these results to policy implementation for efficient disaster prevention planning and reconstruction budget planning.

There are several researches on economic analysis of disaster damages, losses, and recovery process. Taniguchi et al. developed estimation model of direct damages (stock damages) by earthquakes (Taniguchi et al. 1996), and Park et al. developed the other model for estimating direct damages in tsunami cases (Park et al. 2013). In addition, Toyoda clarified the relationship between direct damage and indirect damage of commerce and industry sector in the Great Hanshin earthquake based on questionnaire survey to enterprises (Toyoda 1996). These researches present methods of analyzing economic damage and losses and also recovery process after disaster; however, the effects from population decline or outflow have not been taken into consideration.

This study expends previous estimation models of the abovementioned and develops a simulation model of economic recovery process that incorporates the population variation amount. Specifically, focusing on the damage of private sector enterprises and population outflow from the disaster-stricken areas, it proposes the time-series recovery process model of regional economy and applies to Shima City which is a coastal city in Mie Prefecture, Japan, and examines the economic recovery process and the damage and losses by using the Nankai Trough earthquake in 2030 as a hypothesis.

2 Methods

2.1 Definitions and Data Used

In this paper, the economic damage is classified into stock damage and flow loss. *Stock damage* is defined as physical damage of capital stock such as buildings, facilities, infrastructure, etc.; *flow loss* is defined as a reduction of cash flow in regional economy due to the decline of production and consumption activities by suffering from disaster.

In addition, the time of recovery completion is specified as when the economic activities return to the baseline of without-disaster case. This study evaluates economic recovery process by comparing the trend of *gross regional production* (*GRP*) between with-disaster and without-disaster cases.

Furthermore, the capital stock is classified into *public*, *private*, and *personal capital stock*. The first one is defined as public facilities and infrastructure such as government office, public hall, square, park, national road, etc.; the second one is the stock of equipment, fix assets and buildings, etc. that private enterprises hold; and the last one is the personal housing and assets of residents. The public capital stocks play the foundational role in urban lives and regional economy and contribute as indirect stocks in production activities. However, due to the amounts invested to productions are quite less than private capital stocks, only the damage of private capital stocks is considered to estimate economic losses in this study.

For the prediction of future population, we use the data from National Institute of Population and Social Security Research (IPSS 2012). As shown in Fig. 1, IPSS predicted that the population of Japan will decline from 128.06 million at the point of 2010 to 116.62 million in 2030 and a further decline to 86.74 million by 2060. In this social background, the models which are dependent on the current economic indices cannot be applied to the damage and loss prediction of disaster which is expected to occur in 20–30 years. As such, this study will propose new estimation method based on the prediction of future economic indices like population, labor and capital inputs, etc.

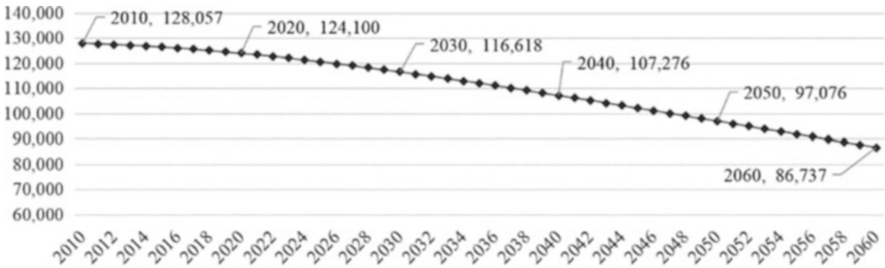

Fig. 1 The population prediction of Japan from 2010 to 2060('000, medium projections, IPSS 2012)

2.2 Research Framework

Based on the existing economic-damage-estimation models, the paper focuses on the damages of private capital and population outflow from disaster-stricken area and develops the economic recovery model using production function. The research framework is shown in Fig. 2.

First, damage to capital stock is estimated using the previous models by Taniguchi et al. and J Pak et al., and the damage of private capital is specified based on previous data. Furthermore, the economic recovery model is built by using the Cobb-Douglas production function as the basic estimation equation of GRP, and the indicators input to model would be calculated based on previous statistics data. Finally, it would be applied to Shima City to examine how the recovery process performs by changing of the exogenous variable such as stock damages and reconstruction policies related to regional economy.

2.3 Estimation of Private Capital Stock Damages

The estimation model of stock damage due to seismic intensity proposed by H. Taniguchi et al. expressed the stock damage $\boldsymbol{Y_{pi,k,t}}$ in region $\boldsymbol{i}$ as the product of the hazards and vulnerability particular to that region (Eq. 1). Specifically, it is the product of $\boldsymbol{N}$, which is the strength of the hazards such as ground motion (maximum speed and seismic intensity), risk of tsunami (maximum tsunami height and inundated area), and other secondary risks, and $\boldsymbol{Se_i,k}$, which is the vulnerability of the quality and amount of capital stock, density, and industrial structure:

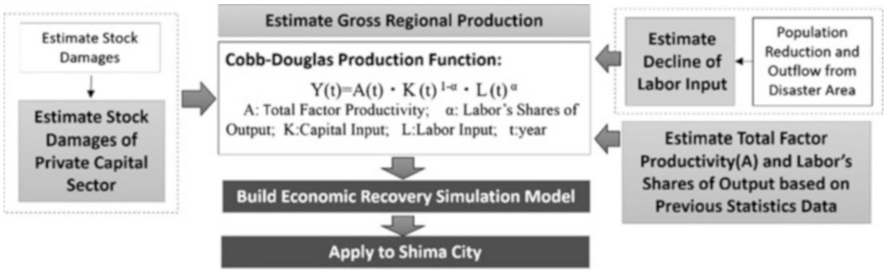

Fig. 2 Research framework

$$Y_{pi,k,t} = \sum (N \times Se_i, k) \tag{1}$$

Thus, the research focusing on the strong correlative relationship between the comprehensive index of MINRYOKU[1] and stock damage[2] developed an estimation equation from the hazard indices (measured seismic intensity, liquefaction potential index, slope failures, and tsunami height) and the comprehensive index of MINRYOKU. Equations 2, 3, and 4 are the estimation equations of stock damage due to seismic intensity proposed by Taniguchi:

$$Y_p = 0.0347 \times Se_{24}{}^{1.3119} \times I \times (0.03 \times PL + 1) \times \begin{pmatrix} D_1 \\ D_2 \end{pmatrix} \tag{2}$$

$$I = \frac{3}{\left(1 + 4.61 \times 10^8 exp^{(-3.5S_i)}\right)} \tag{3}$$

$$Se_{24} = 0.0084 \times Se_{10}{}^{1.0188} \tag{4}$$

Here,

Y_p – Total amount of stock damages (trillion yen)
Se_{24} – Comprehensive index of MINRYOKU (by prefecture, 24 indices)
PL – Liquefaction potential index (weighted average P_L value)
I – Seismic correction coefficient
S_i – Weighted average measured seismic intensity
D_1, D_2 – Adjusted hazard value

$$\begin{bmatrix} \text{When damage from ground motion is the subject, } D1 = 1.00 \\ \text{If a large} - \text{scale slope failure has occurred, } D2 = 4.51 \end{bmatrix}$$

[1] MINRYOKU index is the indication of capacity held by the populace across different fields of regional productivity, consumption, culture, and lifestyle that are divided into prefectures, areas (three to four areas within each prefecture), metropolitan areas, and municipalities.

[2] The stock damage is defined as direct damage in H. Taniguchi' research.

Furthermore, based on the above damage estimation equation due to seismic motion, J. Pak et al. proposed the tsunami damage estimation model with tsunami height as the explanatory variable (Eqs. 5, 6, and 7):

$$\boldsymbol{Y_{tsu}} = 0.0434 \times \boldsymbol{se}_{24}{}^{0.9892} \times \boldsymbol{I_t} \tag{5}$$

$$\boldsymbol{Se}_{24} = 0.0084 \times \boldsymbol{se}_{10}{}^{1.0188} \tag{6}$$

$$\boldsymbol{I_t} = \frac{I_{\mathbf{max}}}{\left(1 + 1.40 \times 10^4 \mathbf{exp}^{(-\mathbf{1.59}, \times \mathrm{H_t})}\right)} \tag{7}$$

Here,

$\boldsymbol{Y_{tsu}}$ – Total amount of direct damage caused by tsunami (trillion yen)
$\boldsymbol{Se_{24}}$ – Comprehensive index of MINRYOKU (by prefecture, 24 indices)
$\boldsymbol{I_t}$ – Tsunami correction coefficient
$\boldsymbol{H_t}$ – Tsunami height (m)
$\boldsymbol{I_{max}}$ – Correction coefficient that responds to specialized solution

$$\begin{bmatrix} \text{For the case of Chilean Tsunami} : \boldsymbol{I_{max}} = \mathbf{6.82} \\ \text{For the case of Okujiricho} : \boldsymbol{I_{max}} = \mathbf{42.25} \end{bmatrix}$$

Using the two equations above, the stock damages can be estimated in the both disaster cases of seismic intensity and tsunami cases. However, in the case of earthquake-tsunami disaster, the amount estimated from tsunami model includes the damages caused by seismic intensity. Therefore, only the tsunami estimation model is adopted while applying to Nankai Trough earthquake.

Specification of the private capital damages from total stock damage amount is required to implement to GRP estimation model. As shown in Table 1, this study uses the estimated data of coastal municipalities in Tohoku four prefectures in the Great East Japan earthquake (Development Bank of Japan Inc. 2011) and calculates the damage ratio of private capital damages to totals. The average percentage is 29.7 %.

Thus, the damages of private capital stocks in the case of earthquake-tsunami disaster can be expressed as Eq. 8:

$$\boldsymbol{Y_{pcs}} = \mathbf{0.297} \times \boldsymbol{Y_{tsu}} \tag{8}$$

Here, $\boldsymbol{Y_{pcs}}$ is the damage amount of private capital stocks.

2.4 Economic Model of Disaster Recovery

GRP in economics can be stated in terms of capital input, labor input, total factor productivity (technology advancement rate), and labor's shares as the Cobb-

Table 1 Private capital stocks damages of coastal municipalities in the Great East Japan earthquake (billion yen, Development Bank of Japan Inc. 2011)

Name of prefectures	Damages of private capital stocks			Total stock damages	Damage of PCS/total SD
		Industry sectors	Other sectors		
Iwate	972	191	781	3522	27.6 %
Miyagi	1420	290	1130	4897	29.0 %
Fukushima	470	151	319	1859	25.3 %
Ibaraki	630	355	275	1483	42.5 %
Total	3492	987	2505	11,760	29.7 %

Douglas production function (Eq. 9). Based on this GRP model configuration, by analyzing and quantifying the influencing factors of each element in terms of with and without disaster in the case of an occurrence of an earthquake, the recovery process based on the amount in regional productivity can be expressed. In this study, estimations will be made by mainly using the decline in private capital stock due to earthquake-tsunami disaster as well as the population decline as the influencing factors for the decrease in GRP:

$$\boldsymbol{Y}(\boldsymbol{t}) = \boldsymbol{A}(\boldsymbol{t}) \times \boldsymbol{K}(\boldsymbol{t})^{1-\boldsymbol{a}} \times \boldsymbol{L}(\boldsymbol{t})^{\boldsymbol{a}} \tag{9}$$

Here,

$\boldsymbol{A}$ – Total factor productivity
$\boldsymbol{\alpha}$ – Labor's shares of output
$\boldsymbol{K}$ – Private capital stock input
$\boldsymbol{L}$ – Labor input
$\boldsymbol{t}$ – year

Normal GRP is converted into real GRP by dividing with inflation rate (Eq. 10):

$$\boldsymbol{Y}(\boldsymbol{t}) = \boldsymbol{GRP_r}(\boldsymbol{t}) = \frac{\boldsymbol{GRP_n}(\boldsymbol{t})}{\boldsymbol{R_i}} \tag{10}$$

Here,

$\boldsymbol{GRP_r}$ – Real GRP
$\boldsymbol{GRP_n}$ – Normal GRP
$\boldsymbol{R_i}$ – Inflation rate

By hypothesizing that the changes in total factor productivity $\boldsymbol{A}(\boldsymbol{t})$ for each year is fixed, then the following is created from the previous statistics date of GRP, labor population and average working hours, investment amount for private capital stocks, and capacity utilization of them (Eqs. 11, 12, 13, and 14):

$$A(t) = \frac{GRP_r(t)}{K(t)^{1-a} \times L(t)^a} \tag{11}$$

Here, we use the formula proposed by Wakita (2008) to estimate labor's shares of output α:

$$a = \frac{c}{GRP_n} \tag{12}$$

C – Compensation of employees

And,

$$L(t) = L_p(t) \times T \tag{13}$$

$L_p(t)$ – Labor force
T – Average annual work hours per person

$$K(t) = K_r(t) \times S \tag{14}$$

K_r – Regional private capital
S – Rate of capacity utilization

Since the statistics data of private capital stock K_r is not published in the level of municipalities, the capital-labor ratio R_{cl} which calculated in prefecture levels is introduced to estimate it. The capital-labor ratio indicates scale of available capital stock on a per-employee basis (Eq. 15). Based on the hypothesizing that the capital-labor ratio of municipality performs the same rate with the prefecture, private capital stock K_r. can be estimated on municipality levels:

$$R_{cl}(t) = \frac{k_r(t)}{L_p(t)} \tag{15}$$

R_{cl} (t) – Capital-labor ratio

The estimation model of GRP can be given by using above formulas. For the future prediction, this study considers the changes of total factor productivity (A), labor force (L_p), and capital-labor ratio (R_{cl}) which determine the private capital amount input to production. Labor force (L_p) can be revealed from working-available-population data which is published by IPSS; the total factor productivity (A) and capital-labor ratio (R_{cl}) are predicted from previous estimation data of the year 2005 and 2009 by hypothesizing that the changes in them for each year are fixed.

3 Case Study of Shima City

3.1 Subject Area

Shima City is a coastal city with a population of 54,000 and a gross area of 180 km^2, with a focus on the industry of fishery and tourism. As the rate of aged people is above 30 %, it is also an area which has vulnerability to disaster risk.

After the Great East Japan earthquake, the Cabinet Office specified 139 municipalities as the areas requiring particularly intensified measurement to prevent Nankai Trough earthquake (Cabinet Office 2014). As one of these areas, Shima City is assumed seismic intensity 7 and 25 m in maximum tsunami height in Nankai Trough earthquake. It is also predicted as the largest inundation area with tsunami height more than 2 m in Mie Prefecture. According to the estimations from Mie Prefecture, it turns out that Shima City has 20,000 collapse buildings and 5200 lives were lost, which is equivalent to 10 % of the regional population (Mie Prefecture Department of Disaster Prevention 2014). It is considered that such large damages would be related to substantial impact to regional economic environment.

However, the economic damages of Shima City by Nankai Trough earthquake have not emerged while it has been estimated in prefecture levels. Thus, this study applies the above models to Shima City to estimate the economic damage and losses and also examine the recovery process in Nankai Trough earthquake.

3.2 Indices Estimations

Lists below show the data used in stock damage estimation and the results.

- Data used in stock damage estimation
  - Maximum height of tsunami of Shima (Cabinet Office 2014) – 26 m
  - Comprehensive index of MINRYOKU (Asahi Shimbun Publishing Co. 2013) – 60.4
- Estimation results of stock damage
  - Amount of stock damage – 454,278 million yen
  - Amount of private stock damage – 134,920 million yen

Tables 2 and 3 show each index used as a substitute and the estimation results by applying the model to Shima City.

As expressed in the previous chapter, the total factor productivity ($\mathbf{A}(\boldsymbol{t})$) and capital-labor ratio ($\boldsymbol{R_{cl}}(\boldsymbol{t})$) are predicted based on the hypothesis of that the changes in them for each year is fixed; and the average rate of labor's shares in 2005 and 2009 is used in the estimation:

Table 2 Data used in economic model and estimation results of indices

Indices	2005	2009
R_i [a]	100.4 %	100.7 %
GRP_n [b]	117,347	105,571
L_p [b]	29,952	27,241
T [b]	1850	1850
$K_{p/Mie}$ [c]	11,823,946	14,330,348
$L_{p/Mie}$ [d]	968,343	943,072
S [e]	76.7 %	76.7 %
C [b]	82,600	76,236

[a] Statistics Bureau (2015)
[b] Mie Prefecture (2011)
[c] Cabinet Office (2013)
[d] Statistics Bureau (2010)
[e] Ministry of Economy, Trade and Industry (2014)

Table 3 Estimation results of indices

Indices	2005	2009
$GRP_r = GRP_n / R_i$	116,879	104,837
$R_{cl} = K_{p/Mie} / L_{p/Mie}$	12.21	15.20
$K_{p/Shima} = L_p \cdot R_{cl}$	365,729	413,938
$K_{Shima} = K_{p/Shima} \times S$	280,514	317,490
$a = C / GRP_n$	70.39 %	72.21 %
$A = GRP_r(t) / (K(t)^{1-\alpha} \times L(t)^{a})$	168.76	182.98

$$A(t) = A(t-1)) + \frac{(A_{2009} - A_{2005})}{4} \tag{16}$$

$$R_{cl}(t) = R_{cl}(t-1) + \frac{(R_{cl2009} - R_{cl2005})}{4} \tag{17}$$

$$a(t) = Average(a_{2005}, a_{2009}) \tag{18}$$

Other data used for prediction future GRP:

$L_p(t)$ Using the predicted data from IPSS
T Using fixed data 1850
S Using fixed data 76.7 %

3.3 Result of Prediction GRP in Shima City

Figure 3 shows the result of GRP estimated from 2010 to 2040. As shown in it, GRP in Shima would run into the maximum value (120,426 million yen) in 2025 and then change to decreasing tendency from 2026. It means that the decreasing rate of

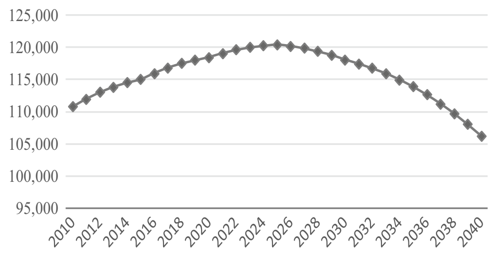

Fig. 3 GRP transition of Shima City estimated by model (million yen)

labor force which effects to GRP becomes bigger than increasing rate of capital-labor ratio and total factor productivity from 2026.

With the labor-saving investment of stock, improvement of working environment, etc., the capital-labor ratio has been in the tendency of rising. In addition, total factor productivity is also increasing by promotion of technical innovation and increase in labor productivity. Therefore, in consideration of the significant decline of population, it is important to make efforts to raise the two indices by efficiency policy implemention.

4 Simulation Results and Discussion

4.1 Disaster Scenario for Simulation

This study applies the GRP model to the disaster cases of Nankai Trough in Shima City and considers economic impacts and how it performs in several cases with different disaster prevention and reconstruction measures. The scenarios are set up as follows:

Case 1(basic damage scenario): It is defined as basic simulation without any measures both before and after disaster, due to the comparison with other cases which include a sort of measures of disaster prevention and reconstruction. It is hypothesized that Nankai Trough earthquake error will occur in 2030, and the completion of stock reconstruction will be in 3 years while the completion of economy rehabilitation in 10 years by referring to the recovery case of Kobe in the Great Hanshin earthquake (Section of Sougoukikaku 2004). Regarding reduction of labor force after disaster, both population outflow and the number of deaths by disaster are considered. For the rate of population outflow after disaster, this study uses the value 8.7 %, by referring to the average rate of coastal areas in Tohoku four prefectures that suffered the Great East Japan earthquake (Koike 2013) and, for the number of laborer deaths, uses the value 5200 assumed by Mie Prefecture, multiplied by the ratio of employees in the total population (Mie Prefecture Department of Disaster Prevention 2014).

Case 2 (disaster prevention measures for reducing primary damage): It is hypothesized that both the damage amount of capital stocks and the number of deaths declined by one-third, by building a large seawall, tide embankment, or breakwater, etc. before Nankai Trough.

Case 3 (policy implementation for decreasing population outflow): The rate of population outflow would decline by half due to several measures like maintaining and creating employment, early recovery of living environment, etc.

Case 4 (providing reconstruction subsidy to private enterprises): 1 billion yen of reconstruction subsidy is granted by the local government for private enterprises who suffered from the disaster, and it is hypothesized that all of the subsidy would be used for rebuilding factories, investment of new equipment, and so on. It can be shown as an increase in capital stock investment in the recovery process.

4.2 Results and Discussion

Figures 4 and 5 show the results of simulation based on the scenario set up above.

Comparing with basic scenario of case 1, both the measures in case 2 and case 3 are effective for reduction of economic damage, while case 4 shows little change in recovery process.

In the case 1 of basic damage scenario, the amount of stock damage is estimated as 454,275 million yen, while the flow loss (decreasing of GRP) is 133,266 million yen. It is equivalent to 5.6 times of GRP of 2009.

In case 2 (measures for reducing primary damage), it is performed that economic damage is reduced significantly as the amount of stock damage is estimated to be 302,850 and flow loss 76,161 million yen, which is the least amount in four cases. In addition, the time needed to complete rehabilitation of GRP to non-disaster case is shorten to 8 years.

Case 3 (policy implementation for decreasing population outflow) performs the shortest recovery time in four cases which is 6 years, and the amount of flow loss is estimated to be 75,172 million yen.

As shown in Fig. 5, the recovery process in case 4 is not improved by the measure of granting reconstruction subsidy to private enterprises, since the flow loss is estimated to be 132,397 million yen, and it also needs 10 years to recover regional economy.

From the above four cases, it is revealed that preliminary measure related to disaster risk reduction for protecting human life and reducing stock damage is most effective to decrease impacts to regional economy. In addition, the policies related to reduction of population outflow are efficient to bring forward time of economic recovery after disaster.

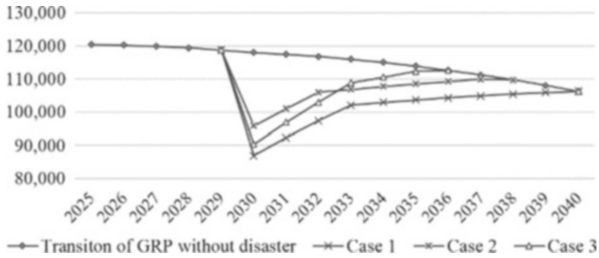

Fig. 4 Result of case 1, 2, and 3 (million yen)

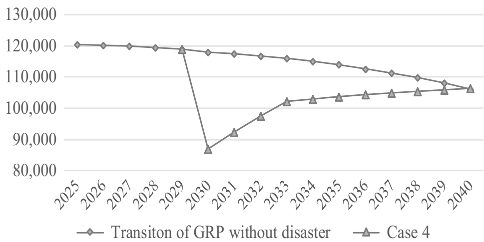

Fig. 5 Result of case 4 (million yen)

5 Conclusion

The economic model of estimating flow losses (reduction of GRP) of disaster is developed in this study, and the simulations of economic recovery process are conducted in four different cases in Shima City by hypothesizing the occurrence of Nankai Trough earthquake in 2030. The following indicates findings that were made clear from this study:

1. Considering account population decline and the changes in the social-economic system, this paper proposes a prediction model of economic recovery process in accordance to the scenario that rehabilitation would be complete in 10 years of the 2030 Nankai Trough earthquake (case 1).
2. Simulations of economic process are conducted based on the model by implementation of policy cases: building seawall before disaster (case 2), measures for decreasing population outflow (case 3), and reconstruction subsidy to private enterprises (case 4). It is revealed that case 2 and case 3 can shorten recovery time to 7 and 6 years due to policy implementation, while little change in recovery process is shown in case 4.
3. The amount of economic damage (stock damage and flow loss) of Shima City is estimated. As a result, the amount of stock damage is estimated to be 454,275 million yen (302,850 million yen in the case 2), while the flow loss is estimated to be 133,266 million yen in case 1, 76,161 million yen in case 2, 75,172 million yen in case 3, and 132,397 million yen in case 4.

In the future, the economic recovery model should be improved by using comprehensive and generic data. As one example, the Minryoku Data used in this study is only published in Japan, then it needs to search other substitute data while adapt to other countries' cases. Therefore, improving generalization of the model is required which make it available to adapt not only to earthquake and tsunami cases in Japan but also to other disasters in many countries.

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References

Asahi Shimbun Publishing Co. (2013). *MINRYOKU marketing database 1989–2013*. Tokyo: Dai Nippon Printing Co., Ltd.

Cabinet Office (2013). *Prefecture private capital stock*. http://www.esri.cao.go.jp/jp/sna/data/data_list/kenmin/files/contents/main_h21stock.html. Accessed 31 Aug 2015.

Cabinet Office (2014). *Areas requiring particularly intensified measurement for Nankai Trough Earthquake*. http://www.bousai.go.jp/jishin/nankai/. Accessed 31 Aug 2015.

Development Bank of Japan Inc. (2011). *Estimation of damage amount of capital stocks in the Great East Japan earthquake: Based on prefectures and municipalities*. http://www.esri.go.jp/jp/workshop/forum/110623/gijishidai47_2.pdf. Accessed 31 Aug 2015.

Hitoshi Taniguchi, Kanto Ayako, Mochizuki Toshio, Ogawa Yujiro. (1996). Economic impact of an earthquake: Estimation of the amount of direct damage. *Comprehensive Urban Studies*, Special edition Vol. 61:167–181.

Koike, S. (2013). On the transition of migration associated with the Great East Japan earthquake: Analysis by municipality in Iwate, Miyagi and Fukushima. *General Index to the Quarterly of Social Security Research, 46*(3), 256–269.

Mie Prefecture (2011). *Municipal economic counting*. http://www.pref.mie.lg.jp/DATABOX/37310002734.htm. Accessed 31 Aug 2015.

Mie Prefecture Department of Disaster Prevention (2014). *Results of earthquake damage investigation (hazard related)*. http://www.pref.mie.lg.jp/D1BOUSAI/jishinhigaisoutei-point2014/hazard_point.pdf. Accessed 31 Aug 2015.

Ministry of Economy, Trade and Industry (2014). *Mechanism and perspective of industrial production index*. http://www.meti.go.jp/statistics/tyo/iip/. Accessed 31 Aug 2015.

National Institute of Population and Social Security Research (IPSS). (2012). *Future estimated population by region in Japan*. http://www.ipss.go.jp/syoushika/tohkei/newest04/sh2401smm.html. Accessed 31 Aug 2015.

Park, J., Cui, Q., & Taniguchi, H. (2013). Study on the analytical method of economic rehabilitation planning of disaster-stricken areas based on the past earthquakes and tsunami. *Studies in Regional Science, 43*(3), 291–305.

Section of Sougoukikaku, Kikakuchoseikyoku (2004). *The population of Kobe City exceeds that before the Great Hanshin earthquake. Statistical Report of Kobe City, an Extra Edition*. http://www.city.kobe.lg.jp/information/data/statistics/toukei/img/sinsaimaekoeru.pdf. Accessed 31 Aug 2015

Statistics Bureau, Ministry of International Affairs and Communications (2010). *National Census, Mie*. http://www.pref.mie.lg.jp/DATABOX/library/kokucho/2010/indext.htm. Accessed 31 Aug 2015.

Statistics Bureau, Ministry of International Affairs and Communications (2015). *Time-series data of consumer price index*. http://www.stat.go.jp/data/cpi/. Accessed 31 Aug 2015.

The International Disaster Database EM-DAT (2015) http://www.emdat.be/. Accessed 31 Aug 2015.

The United Nations Office for Disaster Risk Reduction (UNISDR) (2015). *Sendai framework for disaster risk reduction 2015–2030, The third UN World Conference on Disaster Risk Reduction (WCDRR)*. http://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf. Accessed 31 Aug 2015.

Toyoda, T. (1996). Some economic problems of the Great Hanshin earthquake. *Journal of Political Economy, 173*(5), 1–11.

Wakita, S. (2008). *A perspective on Japanese economy*. Tokyo: Yuhikaku Publishing Co., Ltd.

Part V
Emerging Research Fields

Environmental Education by Playing an Industrial Waste Game: A Comparison Between Chinese, Korean, and Japanese University Students

Hiroe Maeda, Yukio Hirose, and Kyosuke Ohana

Abstract The purpose of this study was to investigate the validity of the Industrial Waste Game as a tool for environmental education in both developed and developing countries. Players are expected to understand first-order dilemmas in illegal dumping: the individual benefits and the total costs of environmental pollution. They are also expected to consider second-order social dilemmas and solutions: these relate to effective measures, such as monitoring, as well as understanding that these measures require cooperation. Regarding the environmental educational effect, we examined players' interest in the industrial waste issue and their understanding of the second-order dilemma. We conducted the game in three countries in 2008, with 46 Chinese, 54 Japanese, and 33 Korean university students. In addition, a control group of 26 Korean nonplayers answered the questionnaire. The questionnaire consisted of four indices: degree of interest in the industrial waste problem, effectiveness of the social solutions for illegal dumping, effectiveness of the individual solutions for illegal dumping, and necessity of cooperation. The Chinese players came to think that the social solutions were more effective. The Japanese players showed a greater degree of interest, as well as a more positive attitude toward the effectiveness of both the social and individual solutions after the game. The Japanese and Korean players demonstrated a more positive attitude toward the effectiveness of both the social and individual solutions than did the

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Chinese players. We confirmed these environmental educational effects not only in Japan but also in other Asian countries.

Keywords Industrial Waste Game • Illegal dumping • Environmental education • Social dilemma • International comparison

1 Introduction

The Industrial Waste Game (Hirose et al. 2004) simulates both the first-order social dilemma of illegal dumping and the second-order dilemma relating to monitoring waste as a preventive measure. In the first-order dilemma, players choose to dump hazardous industrial waste illegally rather than to dispose of it properly, because the cost of proper disposal is higher than that of illegal dumping. The costs of dealing with illegally dumped hazardous waste are then borne by the whole society (in reality, this would be financed by tax funds; however, in the game, all players have to pay the same amount of money). In this situation, each person has to pay a sum less than the cost of proper hazardous waste disposal, but the total cost to society is larger than that which would have been incurred if each person had disposed of his or her own hazardous waste properly. Therefore, individual contributions form the basis for the solution to illegal dumping, but as long as illegal dumping remains individually cheaper than proper disposal, the problem is likely to continue.

In the second-order dilemma portion of the game, the rules of monitoring illegal dumping are introduced, along with associated penalty charges. The rules of monitoring are simulated using the actual laws surrounding police or local government monitoring and illegal dumping as a finable offence. Each player can monitor illegal dumping by paying a monitoring fee because, in reality, police or local governments also bear a large cost for monitoring. If players are monitored and found to have illegally dumped hazardous waste, they have to pay a penalty charge. If the players monitor one another, monitoring functions as a preventive measure against illegal dumping. Therefore, it is important both to create social systems to prevent illegal dumping and to establish social-wide cooperation to function within these systems. However, the latter is difficult; as in a second-order dilemma, players tend to rely on others to pay for monitoring; and if no one pays for monitoring, illegal waste disposal increases. In such cases, some other social system—like a deposit—may be required. Therefore, in order to solve the problem of illegal dumping, it is necessary both to create social systems that target illegal dumping and to ensure cooperation within these systems.

Through the game, players can learn why some waste disposers engage in illegal dumping and why it is difficult to prevent. Players are expected not only to understand the individual benefits of illegal dumping and the total cost of environmental pollution caused by illegal dumping but also to consider effective measures against it, such as monitoring, penalty charges, and deposit systems. The purpose of this study is to examine the validity of the Industrial Waste Game (Hirose et al. 2004) as a tool for environmental education in both developed and developing countries. Each group needs only one deck of cards and a writing tool to play the Industrial Waste Game. This simplicity means that the game can be played all over the world. Therefore, it is feasible to examine the effects of the game on promoting environmental education in both developed and developing countries. Regarding the environmental educational effect, previous studies (Hirose et al. 2004; Ohtake and Hirose 2005, 2007) have examined only the players' interest in and understanding of the industrial waste issue, as well as the causes and effects of social dilemmas, but here we also examine their understanding of the second-order dilemma.

2 Methods

2.1 Participants and Procedure

We conducted the game in three countries in 2008 with 46 Chinese, 54 Japanese, and 33 Korean university students. In addition, a control group of 26 Korean nonplayers participated in this study. Because the original versions of the Industrial Waste Game rules and questionnaires were written in Japanese, Chinese and Korean graduate students at Nagoya University translated them into their respective languages. They also facilitated gameplay in their respective countries and explained current industrial waste and illegal dumping issues after the games.

Players were divided into groups of approximately five people. Because the Industrial Waste Game involves two levels of cost monitoring and another two levels of penalty charges, one of four combinations of monitoring and penalty conditions was assigned to each group.

The Chinese and Japanese participants filled out questionnaires before and after the game. The 46 Chinese players answered the questionnaire items before the game, and 40 Chinese players also answered the questionnaire items after the game. The 54 Japanese players answered the questionnaire items both before and after the game. The 33 Korean players answered the questionnaire only after the game, and the 26 Korean nonplayers also answered the questionnaire items.

In all, the numbers of questionnaires completed and analysed were as follows: from the Chinese, 43 (before the game) and 37 (after the game); from the Japanese, 51 (before and after the game); and from the Koreans, 28. In addition, questionnaires from 20 Korean nonplayers were completed and analysed.

2.2 Questionnaire

The questionnaire was based on four indices.

2.2.1 Degree of Interest in the Industrial Waste Problem

Respondents were asked about their intent to gather information about the issue of industrial waste. Specifically, two questions were asked: one question inquired about the respondents' intent to watch a television programme on industrial waste, and the other asked about their intent to read a magazine containing information about industrial waste.

2.2.2 Effectiveness of the Social Solutions to Illegal Dumping

Four questions were asked about the anticipated effects of social solutions to illegal waste dumping. They covered the effects on industry-wide funding, tacking a fee onto product prices, penalty charges, and monitoring.

2.2.3 Effectiveness of the Individual Solutions to Illegal Dumping

Two questions were asked: one was about whether it was necessary to separate one's own waste if many others do so, and the other was whether it is futile to separate one's waste if others do not.

2.2.4 Necessity of Cooperation

Two questions were asked about the necessity of general social cooperation: one was whether such cooperation is needed because it is impossible to leave the solution to the waste management issue to others, and the other was whether it is needed because it is impossible to solve the waste management issue on one's own.

We asked the participants to answer each question on a scale ranging from 1 (totally disagree) to 7 (totally agree).

3 Results

3.1 Mean Differences Between Samples in Measured Variables

Responses on a 7-point scale ranging from 1 (totally disagree) to 7 (totally agree) were scored as 1–7 point(s), respectively. Responses on reverse-coded items were scored as 7 (totally disagree) to 1 (totally agree).

Table 1 shows the mean values and standard deviations of the responses for the measured variables in each of the three countries. For two items of interest on the

Table 1 Means and standard deviations of the measured variables in each of the three countries (responses by players after the game)

Item	Chinese ($n = 37$) M(SD)	Korean ($n = 28$) M(SD)	Japanese ($n = 51$) M(SD)
I would like to read a magazine if it has some contents about industrial waste	5.70 (1.31)	3.93 (1.70)	3.67 (1.60)
I would like to watch a television programme on industrial waste	5.86 (1.27)	4.14 (1.65)	3.63 (1.59)
If there is no monitoring, no company will dispose of industrial waste properly	4.24 (1.89)	6.04 (1.48)	5.90 (1.65)
If there is no system of penalty charges, no company will dispose of industrial waste properly	4.86 (1.72)	6.14 (1.35)	5.75 (1.55)
It is impossible to solve the issue if funds raised industry-wide are needed to treat illegally dumped waste	4.22 (1.69)	5.11 (1.57)	5.04 (1.47)
The issue of illegal dumping cannot be solved if we tack the fee for treating waste onto product prices	4.30 (1.78)	5.07 (1.39)	4.78 (1.54)
If everyone separates batteries and so on, it is no problem if I alone don't do it (R)	6.32 (1.20)	5.14 (1.72)	5.22 (1.83)
If only I separate waste, it is not effective to solve the problem, because others don't (R)	5.60 (1.80)	4.64 (1.81)	4.69 (1.91)
What matters is what everyone does, because there is no way we can leave the solution to the waste management issue to others	5.78 (1.75)	4.89 (1.59)	5.49 (1.58)
It is necessary for everyone to cooperate to solve the waste management issue because I can't solve it alone	6.62 (1.28)	5.86 (1.33)	5.73 (1.42)

Note. Items with (R) correspond with reverse-scored items

issue of industrial waste, the mean responses of the Korean and Japanese participants were around 4 points; that is, they were slightly more positive than neutral. On the other hand, the Chinese participants' mean responses were over 5, meaning that they showed relatively strong positive attitudes.

Conversely, for the four items on the 'effectiveness of the social solutions to illegal dumping', the Korean and Japanese participants averaged between 5 and 6 points, respectively, meaning that they showed relatively strong positive attitudes; the Chinese participants averaged around 4 points, meaning that they were only slightly more positive than neutral.

Among the items on the 'effectiveness of the individual solutions', the Korean and Japanese participants averaged over 5 on 'If everyone separates batteries and so on, it is no problem if I alone don't do it', while the Chinese participants averaged over 6. The Korean and Japanese participants averaged over 4 on 'If only I separate waste, it is not effective to solve the problem, because others don't', while the Chinese participants averaged over 5. The Chinese participants had lower averages than the Korean and Japanese participants on both items; thus, they found individual solutions more effective than their counterparts in Japan or Korea.

For each of the two items concerning the 'necessity of cooperation to solve industrial waste problems', the Chinese showed stronger positive attitudes than the Korean and Japanese participants. The latter averaged between 4 and 5 on 'What matters is what everyone does, because there is no way we can leave the solution to the waste management issue to others', whereas the Chinese participants averaged over 5. On the item, 'It is necessary for everyone to cooperate to solve the waste management issue, because I can't solve it alone', the Korean and Japanese participants averaged over 5, while the Chinese participants averaged over 6.

3.2 Factor Analysis

Through a factor analysis, four factors were identified (Table 2): (1) interest in the industrial waste problem, (2) effectiveness of the social solutions, (3) effectiveness of the individual solutions, and (4) necessity of cooperation.

Scale scores for each factor were calculated as the average score of the items included in the factor. An analysis of these four indices revealed significant differences between the three countries (Table 3). The Chinese players demonstrated more positive interest in the industrial waste problem than the Japanese and Korean players. On the other hand, the Japanese and Korean players demonstrated more positive attitudes toward the effectiveness of the social solutions and individual solutions than the Chinese players. Moreover, the Chinese players showed more positive attitudes toward the necessity of cooperation than the Korean players.

3.3 Comparisons in Scale Scores Before and After the Game by T-Test

3.3.1 Chinese Players

We compared scale score means on the questionnaires administered before and after the game to examine whether the Chinese players had begun to collect information on industrial waste management from television or magazines voluntarily; whether they had begun to think that both individually separating waste and creating social systems involving monitoring, penalty charges, or fundraising were effective solutions to illegal dumping; and whether they understood that illegal dumping should be tackled by the cooperation of society as a whole. Table 4 shows the scale score means and standard deviations of the Chinese participants' responses on the questionnaires administered before and after the game. The Chinese players tended to think the social solutions to illegal dumping were more effective after the game ($t(78) = -1.65$, $p < 0.10$). There were no significant differences in the other three scale scores (interest in the industrial waste problem,

Table 2 Results of factor analysis (maximum-likelihood estimation method, varimax rotation, total of three countries' data, after the game ($n = 116$))

Item	1	2	3	4
I would like to watch a television programme on industrial waste	.98	−.09	−.08	.08
I would like to read a magazine if it has some contents about industrial waste	.95	−.07	−.08	.06
It is impossible to solve the issue if funds raised industry-wide are needed to treat illegally dumped waste	.09	.86	.12	.01
The issue of illegal dumping cannot be solved if we tack the fee for treating waste onto product prices	.13	.73	.04	.09
If there is no system of penalty charges, no company will dispose of industrial waste properly	−.25	.60	−.01	.01
If there is no monitoring, no company will dispose of industrial waste properly	−.24	.59	.06	.09
If everyone separates batteries and so on, it is no problem if I alone don't do it (R)	.01	.16	.98	−.09
If only I separate waste, it is not effective to solve the problem, because others don't (R)	−.12	.01	.66	−.02
What matters is what everyone does, because there is no way we can leave the solution to the waste management issue to others	−.07	.07	.05	.99
It is necessary for everyone to cooperate to solve the waste management issue because I can't solve it alone	.16	.07	−.12	.64
Eigenvalue	2.04	2.03	1.45	1.43

Note. Items with (R) correspond with reverse-scored items

Table 3 Means and standard deviations of scale scores for the three countries (responses by players after the game)

	Chinese ($n = 37$)	Korean ($n = 28$)	Japanese ($n = 51$)
	M(SD)	M(SD)	M(SD)
Interest in the industrial waste problem	5.78a (1.27)	4.04b (1.64)	3.65b (1.56)
Effectiveness of the social solutions	4.41a (1.46)	5.59b (0.91)	5.37b (1.19)
Effectiveness of the individual solutions	5.96a (1.27)	4.89b (1.69)	4.95b (1.69)
Necessity of cooperation	6.20a (1.33)	5.38b (1.25)	5.61 (1.41)

Note. Similar letters (i.e. a and b) indicate no significant difference

$t(78) = -1.00$, *n.s.*; effectiveness of the individual solutions, $t(78) = -1.36$, *n.s.*; necessity of cooperation, $t(78) = -0.54$, *n.s.*).

3.3.2 Japanese Players

Table 5 shows the scale score means and standard deviations of the Japanese players' responses on the questionnaires administered before and after the game.

Table 4 Scale score means and standard deviations of responses on questionnaires administered before and after the game (Chinese participants)

	Before the game ($n = 43$)		After the game ($n = 37$)	
	M	SD	M	SD
Interest in the industrial waste problem	5.52	1.06	5.78	1.27
Effectiveness of the social solutions	3.91	1.18	4.41	1.46
Effectiveness of the individual solutions	5.51	1.62	5.96	1.27
Necessity of cooperation	6.35	1.09	6.20	1.33

Table 5 Means and standard deviations of scale scores before and after the game (Japanese participants)

	Before the game ($n = 51$)		After the game ($n = 51$)	
	M	SD	M	SD
Interest in the industrial waste problem	3.24	1.22	3.65	1.56
Effectiveness of the social solutions	5.00	1.04	5.37	1.19
Effectiveness of the individual solutions	5.31	1.53	4.95	1.65
Necessity of cooperation	5.50	1.41	5.61	1.41

Table 6 Scale score means and standard deviations of the Korean players (after the game) and nonplayers

	Nonplayers ($n = 20$)		Players (after the game) ($n = 28$)	
	M	SD	M	SD
Interest in the industrial waste problem	3.98	1.53	4.04	1.64
Effectiveness of the social solutions	5.84	0.74	5.59	0.91
Effectiveness of the individual solutions	4.90	1.83	4.89	1.69
Necessity of cooperation	5.83	1.08	5.38	1.25

The Japanese players showed more positive attitudes toward the degree of interest in the industrial waste problem, the effectiveness of the social solutions, and the effectiveness of the individual solutions after the game ($t(50) = -2.58$, $p < 0.05$; $t(50) = -2.55$, $p < 0.05$; $t(50) = -2.08$, $p < 0.05$). There were no significant differences before and after the game for the necessity of cooperation scale score ($t(78) = -1.36$, *n.s.*).

3.4 Comparisons in Scale Scores of Players and Nonplayers by T-Test

Table 6 shows the scale score means and standard deviations for the Korean players (after the game) and nonplayers. A comparison between the Korean players and nonplayers showed no significant effects ($t(46) = -0.13$, *n.s.*; $t(46) = -1.00$, *n.s.*; $t(46) = 0.08$, *n.s.*; $t(46) = 1.30$, *n.s.*).

4 Discussion

From the results, we identified four factors explaining the Industrial Waste Game's effects on environmental education.

Here, we discuss each of these environmental educational effects, focusing on the similarities and differences between players from each of the three countries tested. We also discuss the environmental education effects of the Industrial Waste Game based on comparisons of the players' responses before and after the game (Chinese and Japanese participants) and on comparisons between players and nonplayers (Korean participants).

4.1 Interest in Information About Waste Management Problems

Ohtake and Hirose (2007) also measured interest in information about waste management problems in their study on environmental education for Japanese high school students using the Industrial Waste Game. They reported mean values of around 3 on the 7-point scale used herein. In contrast, the players in each of the three countries in this study averaged over 5 points on the 7-point scale. Therefore, university students showed more interest in industrial waste management problems than high school students did, after the game.

The Japanese players showed significantly higher interest in industrial waste management problems after the game compared to before it; they also showed significantly higher interest in these issues compared to nonplayers. The Chinese players averaged over 5 points in their questionnaire responses before the game; however, they may thus have demonstrated a ceiling effect. In other words, it would have been difficult to increase players' interest through the game if they already had a relatively high interest in the game's issues. The Korean players averaged around 4 points in their questionnaire responses after gameplay, meaning that their degree of interest was neutral and, thus, that there was room for improvement through debriefing and other methods.

4.2 Effectiveness of the Social Solutions to Illegal Dumping

This index was original to our study. There were significant differences between the Chinese and Korean players and between the Chinese and Japanese players. The Korean and Japanese players showed positive attitudes toward the effectiveness of the social solutions. In the comparisons between the Chinese and Japanese players before and after the game, both groups showed significantly higher scale scores after the game.

4.3 *Effectiveness of the Individual Solutions to Waste Management Problems*

Ohtake and Hirose (2007) reported that Japanese high school students' mean responses were 4 to 5 points on a 7-point scale (after reverse coding). On the other hand, in this study, the Korean and Japanese players averaged between 4 and 5, and the Chinese players averaged between 5 and 6 (after reverse coding). Therefore, the Japanese and Korean university students were similar to the Japanese high school students in their attitudes toward individual solutions. The Chinese university students thought individual solutions were more effective than each of these comparison groups.

In comparisons of the Chinese and Japanese players before and after the game, only the Japanese players showed significantly lower postgame scale scores. In this study, the Japanese players did not have enough time to debrief after the game, and the follow-up debriefing about the necessity of proper disposal, which was conducted the following week, occurred after the students had answered the postgame questionnaires. Therefore, it is possible that some Japanese players who answered postgame questionnaires thought that illegal dumping was cheaper than proper disposal or did not understand the necessity of proper disposal by individuals. Ohtake and Hirose (2007) reported that the students in their postgame debriefing thought that individual solutions were more effective when compared to the students in the only game or control group. Therefore, Japanese and Korean students should demonstrate a sufficient understanding of the necessity of individual solutions through a refinement of the debriefing protocol.

4.4 *Necessity of Cooperation*

Ohtake and Hirose (2007) reported that the mean scale scores of Japanese high school students were between 5 and 6 points on the 7-point scale just after the game. The Japanese university student players in this study demonstrated scores similar to those of the Japanese high school students immediately after the game. The Chinese players showed slightly higher, and the Korean players slightly lower, scale scores. In the comparisons among the three countries, there were significant differences between only the Chinese and Korean players.

In addition, no significant differences were found in comparisons between the Chinese and Japanese players' responses before and after the game and between the Korean players' and nonplayers' responses. However, Ohtake and Hirose (2007) reported significant differences between high school student players' attitudes about the necessity of cooperation before and immediately after the game, as well as after 3 months of gameplay. In this study, we examined the educational effect only immediately after the game; in addition, the Japanese players did not debrief enough after the game. Debriefing about the necessity of proper disposal was conducted the following week. Therefore, when the Japanese players answered the questionnaires just after the game, some of them may have thought that illegal dumping was cheaper than proper disposal. Ohtake and Hirose (2007) reported that students who were debriefed after the game thought that individual contributions were more effective when compared to either the students who only played the game or the students in the control group who did not play the game or experience any environmental education. Therefore, Japanese and Korean students might understand the necessity of individual contributions sufficiently if the debriefing protocol were refined. In this study, we examined the effects of environmental education immediately after the game, but experience with the game may also result in long-term effects.

5 Conclusions

The results of our study suggest that the Industrial Waste Game helped players to increase their interest in industrial waste management problems and to understand the first- and second-order social dilemmas of illegal dumping. We confirmed these environmental educational effects not only in Japan, but also in other Asian countries.

For future research, we consider two challenges. First, we should improve the debriefing protocol in each country in order to enhance the educational effect of the game.

Second, there is room to discuss our method of sampling, because the universities were selected arbitrarily in each country. However, all of these universities were national, so our sample may reflect the diversity of each country's university students. Therefore, we think that they serve as a proper sample for the purposes of our study—that is, examining the validity of the Industrial Waste Game as a tool for environmental education, not only in developed but also in developing countries. Conducting the game among various samples and confirming the relevance of our data merit further research.

A limitation of the present study is that our data are relatively outdated. However, there has been no marked change in policies to prevent illegal waste dumping in China or Japan since our study. In Korea, the electronic manifest system was introduced to manage the process of waste disposal in August 2008 (our study was conducted in Korea in April 2008). The government may tighten the monitoring system, but the fact remains that illegal dumping is a social dilemma, and the Industrial Waste Game would be useful in environmental education. Employing training programmes that use the Industrial Waste Game to educate employees of industries with the potential for illegal dumping may actually be worth a great deal in terms of preventing it in the future.

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References

Hirose, Y., Sugiura, J., & Simomoto, K. (2004). Industrial waste management simulation game and its educational effect. *Journal of Material Cycles and Waste Management, 6*, 58–63.
Ohtake, K., & Hirose, Y. (2005). Kotogakko ni okeru kankyo kyoiku to shiteno sangyo haikibutu gemu to sono kyoiku hyoka [The educational effect of the industrial waste game as a tool of environmental education in high school]. *Simyureshon ando gemingu, 15*, 18–26.
Ohtake, K., & Hirose, Y. (2007). Kotogakko ni okeru sangyo haikibutu gemu no zisshi to sono kyoiku koka: Deliburifingu no hoho to koka ni chumoku shite [Educational effectiveness of an industrial waste game in the high school curriculum: Focusing on methods and effects of debriefing after gaming]. *Kankyo kyoiku, 16*, 8–17.

Even Unreliable Information Disclosure Makes People Cooperate in a Social Dilemma: Development of the "Industrial Waste Illegal Dumping Game"

Yoko Kitakaji and Susumu Ohnuma

Abstract This study explores whether information disclosure can cause cooperation in a social dilemma, even when people can disseminate false information. In the past, illegal dumping increased in Japan despite the strengthening of penalties and surveillance laws, due to practical limitations in monitoring and surveillance. To resolve this, the tracking sheet used to trace the trading and processing of the waste must be traceable, in order to detect illegal dumping. This means that manifests must be written precisely in order to be effective, but if maintaining a tracking log has some function other than surveillance, this may not be the case. To examine this issue, we used the "Industrial Waste Illegal Dumping game" (Ohnuma S, Kitakaji Y. Simure-syon ando geimingu (Stud Simul Gaming) 17 (1):5–16, 2007) which simulates the disposal of industrial waste and is structured as a social dilemma with asymmetry of information. In this study we utilized two conditions: a disclosure and a control (need not disclose) condition. Under the disclosure condition, players had to enter the amount of commission or disposal in the landfill but did not have to fill in the correct amount. Although other players could read the report, they did not know who performed illegal dumping or how much they contributed. Therefore, this disclosure did not have an effective surveillance function and could not help detect noncooperation. However, the results showed that the amount of illegal dumping was reduced, and information about payoffs was actually shared more in the disclosure condition than in the control condition. Moreover, players collected and shared their information more in the disclosure condition than in the control condition. The study thus indicates that the function of disclosure is not surveillance, but information sharing which is essential for voluntary cooperation.

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Keywords Social dilemma • Industrial waste • Illegal dumping • Surveillance • Information disclosure

1 Purpose

The purpose of this study was to demonstrate that information disclosure causes cooperation in a social dilemma, even if people can disseminate false information. We used the "Industrial Waste Illegal Dumping Game" (Ohnuma and Kitakaji 2007), which simulated the disposal industry in Japan. The goal of the research is to consider the function of disclosure not only as surveillance but also as information sharing.

1.1 Illegal Dumping and Disposal Systems of Industrial Wastes in Japan from the Social Dilemma Perspective

In Japan, 400 million tons of industrial waste were generated per year in recent years, and approximately 40–50,000 tons of industrial waste were illegally dumped (Japanese Ministry of the Environment 2014). However, the amount of illegal dumping was unknown because the statistics include only the amounts discovered, and it is impossible to discover all cases of illegal dumping. Therefore, it is estimated that far greater amounts of illegal dumping occur. Indeed, 560,000 tons of illegal dumping were discovered 10 years ago. Some industrial waste can have grave impacts on the surrounding environment, and restoring environments damaged by illegal dumping is time consuming and expensive. The costs for restoration are incurred by the dumper, if it is clear who is responsible, but if it is not clear or if the dumper has insufficient assets to cover the cost, the government incurs the cost and restores the environment, which means that the costs are covered by public funds, such as money raised through tax. Recently, an organization of industries has established a fund for restoring sites polluted by illegal dumping. Accordingly, whole industries are assuming some costs for restoration, meaning that certain industries are assuming the responsibility for illegal dumping by themselves.

In this research, we view the illegal dumping problem as a social dilemma. A social dilemma is defined by two properties: (a) Each individual receives a higher payoff for a socially defecting choice than for a socially cooperative choice, no matter what the other individuals in the society do, but (b) all individuals are better off if all cooperate than if all defect (Dawes 1980; Pruitt and Kimmel 1977). Considering the case of illegal dumping, we can think of appropriate disposal as cooperation and illegal dumping as defection. If each agent disposes appropriately, they would preserve the surrounding environment, but if everyone disposed illegally, the surrounding environment would be badly damaged resulting in large restoration costs, which would impact everyone. Moreover, as noted above, industrial waste disposal systems make industries cover the costs of illegal dumping, and consequently, industries systematically produced a social dilemma structure.

One major resolution for a social dilemma problem is structural change to change the payoffs. Examples of such structural change are surveillance and punishment. Many previous studies have shown that sanctions such as surveillance or punishment have caused cooperation (Caldwell 1976; Van Vugt and De Cremer 1999; Wit and Wilke 1990; Yamagishi 1986, 1992). However, sanctions do not work without discovering illegal dumping but, in reality, it is hard to discover illegal dumping. Even though strict punishment already exists for illegal dumping in Japan, strengthening surveillance failed to increase the detection of illegal dumping; instead, strict surveillance resulted in the concealment of illegal dumping (Ishiwata 2002). Therefore, measures other than monitoring and punishment are required to resolve the illegal dumping problem. Goal expectation theory (Pruitt and Kimmel 1977; Yamagishi 1986) emphasizes the expectation of mutual cooperation, that is, (a) one can perceive the situation to seek not personal benefit but public benefit, and (b) one can expect others not to choose to defect but to choose to cooperate. One key factor for promoting mutual expectation is information sharing, particularly when other players' payoffs are uncertain. This study demonstrated the importance of information sharing obtained through information disclosure.

1.2 Studying Social Dilemma Using Simulation and Gaming

Theoretical and experimental researches in social dilemmas have been accumulating and studies using gaming methods have also been developed. For example, SIMINSOC (Hirose 1997) based on Gamson's SIMSOC (1978) and the Industrial Waste Game (Hirose et al. 2004) based on Garbage (Thiagarajan 1991) simulate interactions among players in a social dilemma situation. In these games, players communicate with each other, create situations involving bargaining, and make decisions to maximize their profit while depending on each other.

Shubik (1965) positioned gaming as a kind of antithesis to experimentation. He argued that experimental games pared away many factors from reality because they demand theoretical clarity and precision and to generalize differences in phenomena. On the other hand, gaming weighs interaction among participants rather than constructing sophisticated theories, and thus gaming allows the processes of group dynamics, in which participants affect each other and the interactions create a social situation (Shubik 1965), to be observed. Hirose (2000) noted that one remarkable feature of gaming is its ability to simulate "reality": participants felt that their gaming experiences could occur for real. Furthermore, gaming simulation allows participants to join the process of creating a society, in which consequences can vary according to their interactions, even though an initial setting was provided (Hirose 2000). This feature of gaming is important for research in social dilemmas, because the consequences of a social dilemma depend on members' interactions.

Therefore, many studies on social dilemmas have focused on the effects of discussion. Some of these studies have demonstrated that discussion focused on cooperation is necessary for mutual cooperation, but discussion focused on noncooperation resulted in failure (Deutsch 1958; Deutsch et al. 1967). Another study showed that greater cooperation was observed when participants promised to cooperate as compared to when they participated in discussion only, even though the promise would have no binding force and they could violate any promise without penalty (Orbell et al. 1988). Furthermore, Ostrom (1990) discovered that dialogue prevents the tragedy of the commons in actual societies. Collectively, these findings indicate that dialogue among members is essential for resolving a social dilemma.

Gaming has another advantage. It acts as "a tool for discovering problems" (Armstrong and Hobson 1973). Duke and Geurts (2004), citing Armstrong and Hobson (1973), argued that gaming allows us to invent the future when we reflect on a problem in an intuitive and uncalibrated way. A gaming simulation allows us to understand the complex dynamics involved with giving back to society. This specific study addressed a problem that was hardly noted in social dilemma research, namely, that the function of information disclosure is not only surveillance but sharing goals and encouraging expectations of mutual cooperation.

2 Design of the Gaming

2.1 The Structure of the "Industrial Waste Illegal Dumping Game"

We developed the "Industrial Waste Illegal Dumping Game," which simulates a social dilemma structure. It has six given structures indispensable for examining the illegal dumping problem: (a) a social dilemma structure, (b) different roles, (c) different payoffs and initial information by roles, (d) one-way flow of waste, (e) difficulty of monitoring, and (f) a time lag in the consequence of illegal dumping:

(a) *Social dilemma structure*. Players in the game make decisions to appropriately dispose of waste (cooperation) or to illegally dump it (noncooperation). For individuals, it is more profitable to dump illegally than to dispose appropriately; however, if all players dumped illegally, the total social profit would be less than that if all players disposed appropriately.
(b) *Different roles*. There are three different roles in the game: producing industry, intermediate treatment industry, and terminal industry. Each industry has specific work and is required to do its own work to appropriately dispose of industrial waste. In particular, producing industries generate money and waste as a by-product of production. Producing industries negotiate with intermediate treatment industries and contract out waste treatment to them, paying them a

commission, because the producing industries cannot dispose of waste appropriately by themselves. The intermediate treatment industries can reduce waste, negotiate with terminal industries, and contract out waste treatment to them by paying them. The terminal industries reclaim waste in landfills.

(c) *Different payoffs and initial information by roles*. The payoffs and initial information differed by roles as each role has a different mission from the others relating to appropriate disposal. Costs for appropriate disposal are specific to each industry, and different industries are unaware of the other costs for appropriate disposal. For example, it takes costs to produce, reduce waste, and reclaim in a landfill, but players do not know about the other types of players' costs.

(d) *One-way flow of waste*. As noted above, producing industries have to contract out waste treatment to intermediate treatment industries, and intermediate treatment industries have to contract out to terminal industries. This flow is fixed and the waste cannot travel backward.

(e) *A time lag in the consequence of illegal dumping*. Players can dump illegally whenever and wherever they want to without conforming to the flow. If someone dumps illegally, no one would know who was responsible, nor how much was illegally dumped. The amount of illegal dumping is announced at the end of the game, and then players have to pay money to restore the environment damaged by illegal dumping.

2.2 Rules of the Industrial Waste Illegal Dumping Game

All players in this game are asked to maximize their own benefit. Every player can choose to be cooperative by disposing of waste appropriately (C) or to be noncooperative by dumping waste illegally (D). This choice is a continuous function and nonzero sum, meaning that players can dispose of some waste appropriately and can dump some illegally, if they so chose. Players each assumed one of three roles, with more than two players in each of the roles: producing industries, intermediate treatment industries, and terminal industries. They each have different roles in appropriate disposal.

For appropriate disposal, every player has to determine the amount of waste to dispose of appropriately, make a contract, and pay a commission in face-to-face negotiation. They do not know the payoffs of any other type of player at the beginning of the game (Fig. 1). Any player can communicate with any of the others, but players bargain with a limited type of players. That is, producing industries cannot contract out waste management terminal industries directly.

Players can also illegally dump waste (Fig. 2). Any type of player can choose illegal dumping as noncooperation. If players wanted to dump illegally, they simply put card-shaped waste into one of the "illegal dumping boxes" (Fig. 3) distributed everywhere in the site.

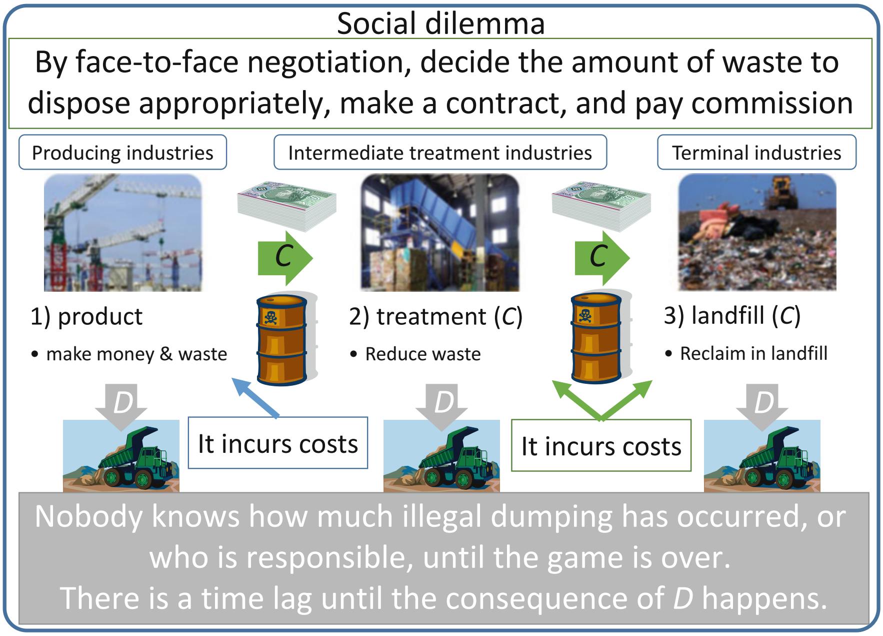

Fig. 1 Flow chart of industrial waste disposal in the game. Cooperative behavior is shown as *C* and noncooperative behavior is shown as *D* in the figure

Fig. 2 A player dumping illegally

Nobody knows how much waste is dumped or who performed the illegal dumping.

There is also a time lag between illegal dumping and its consequences. As a consequence of noncooperation, all players have to pay environmental restoration

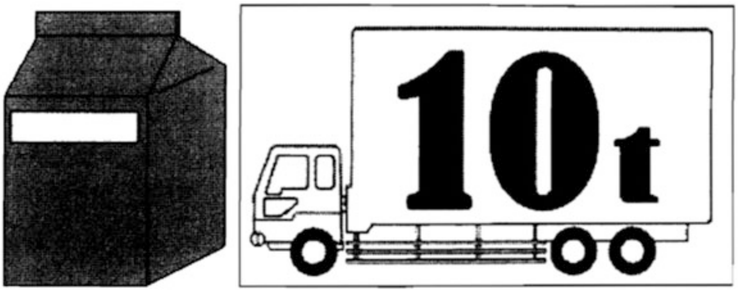

Fig. 3 Tools for the Industrial Waste Illegal Dumping Game. *Left*, illegal dumping box; *right*, card-shaped wastes

expenses according to the total amount of illegal dumping at the completion of all sessions.

Illegal dumping is more profitable than following the appropriate process for each individual in the short term, but the more the illegal dumping that takes place, the less the overall profit will be for all players. The players repeated this decision-making process. After the game ends, the producing industries are fined more than other industries because they have to pay more for illegal dumping than other industries because of the "producer responsibility" for checking appropriate disposal industrial waste.

In addition, producing industries have to pay a fine if they could not submit tracking sheets. If a producing industry failed to obtain one of the first and second management sheets, he or she is penalized. The tracking sheet is proof that they had disposed of waste appropriately. Players stamped the sheets if they had disposed waste appropriately. However, players who dump illegally can manipulate the first or second management sheets and can stamp them even if they did not dispose waste appropriately, because no one could confirm their actions.

2.3 The Perspective of the Research

When contracting out waste treatment to other industries, it is necessary to pass tracking sheets to prove appropriate waste disposal. Each industry stamps and fills in its tracking sheets and returns them to the producing industries upon completion of waste disposal. The producing industries have to check the tracking sheets, which are returned if waste is disposed of appropriately. If tracking sheets are not returned to the producing industry, the producing industry that failed to submit the tracking sheet pays a fine as a result of producer responsibility. However, anyone can fake tracking sheets. Indeed, the descriptions on 60 % of tracking sheets are unreliable (Asaoka et al. 2012) for confirming actual appropriate disposal in Japan.

This study explored the function of the tracking sheet system. If the tracking sheets only serve a surveillance function to encourage cooperation, they are difficult to use effectively. However, if they have a different function from surveillance, i.e., framing the situation as requiring mutual cooperation, they may work. Hence, this study examined the necessary conditions by redesigning the tracking sheet system in the game.

3 Method

3.1 Condition

The players' goal was to maximize self-profit and they were rewarded with snacks according to their final scores in the game.

We set two conditions, a control and a disclosure condition. We manipulated how the tracking sheets were checked. Under the disclosure condition, all the players had to fill in the amount of commission or landfill in the tracking sheets and pass them to the next industry by hand. If any blanks remained in the tracking sheet, the producing industries were penalized and paid a fine. However, they did not have to fill in the correct amount. There were no penalties for mistakes in the document. In the control condition, when producing industries or intermediate treatment industries passed industrial waste to the next industry, they only had to stamp tracking sheets. Players did not have to fill in the amounts of waste disposed. If any tracking sheets were not stamped, the producing industries had to pay penalties (Fig. 4).

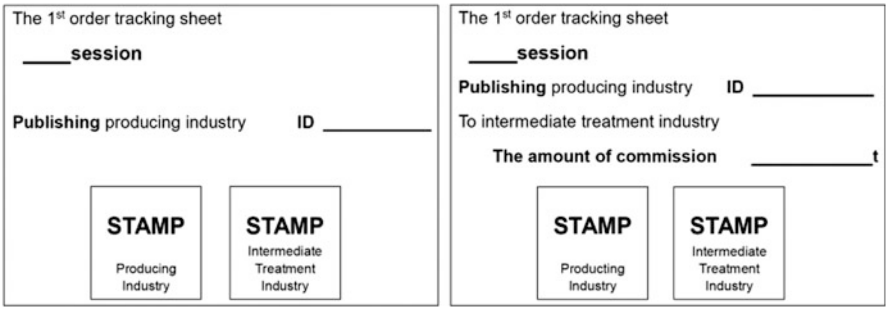

Fig. 4 Examples of tracking sheets. *Left*, a tracking sheet in the control condition; *right*, a tracking sheet in the disclosure condition. In the control condition, there were blanks for stamps in the tracking sheets, but in the disclosure condition, there were blanks for stamps and spaces for the amount of commission

3.2 Participants

We conducted six games in total: three games each for the control and the disclosure conditions. Fifty-six students participated in the study, with 9–12 participants in each game and more than 3 of each type of player.

After general instructions, players were assigned roles by lottery. They were then instructed on the specific rules for each industry. Finally, a practice session and five game sessions were conducted.

3.3 Dependent Valuables

We measured the observed amount of illegal dumping and provided a postgame questionnaire.

The amount of illegal dumping. To assess cooperation, we compared the amount of illegal dumping per person between conditions. After all sessions were completed, we calculated the amount of illegal dumping. No player knew the amount of illegal dumping until the game was over.

Questionnaire. After the game ended, players answered a questionnaire about the degree of shared information, disclosure of information, collection of information, honesty on tracking sheets, effects of information disclosure, cooperation with the same/other industries, and attitude in the game. Participants answered the items except for the items of the degree of shared information on a 7-point scale, from 1 (I do not think so at all) to 7 (I very strongly believe so) to describe their feelings after the game. The contents of the questionnaire were as follows:

The degree of shared information. Players answered whether they knew other players' payoffs. They chose from the following options: practice session, one to five session, or did not know until the end of the game. We labeled their responses as "knew" and "didn't know" in our analysis. We eliminated responses on the payoffs within the same industry and analyzed the remaining findings with a chi-square test. The reason why we eliminated responses on the payoffs within the same industry is because players were informed of the payoffs for their role.

Collecting information. We measured how players tried to collect information. Players rated five items such as "Other players provided information about bargaining or payoffs" and "I collected information about bargaining or payoffs of product (intermediate treatment, or terminal) industries" ($\alpha = 0.74$).

Disclosing information. We asked if players disclosed their information about payoffs or bargaining with five items such as "I provided information about bargaining or payoffs" and "I gave out information about bargaining or payoffs" ($\alpha = 0.47$).

Honesty on tracking sheets. To assess dealing with tracking sheets, we presented two items: "I reported on tracking sheets honestly and I stamped them" and "I felt a sense of obligation to report on tracking sheets honestly and I stamped them."

Effectiveness of information disclosure. To assess the effectiveness of tracking sheets, we presented two items: "Disclosing information about bargaining or payoffs benefitted me" and "Writing down the amount of commission facilitated our communication with each other."

Cooperation with the same/other industries. We asked if players cooperated with the same/other industry player. Cooperation with the same industry consists of two items: "I collaborated with players in the same industry" and "I cooperated with players in the same industry" ($\alpha = 0.98$). Cooperation with the other industry consists of two items: "I collaborated with players in other industries" and "I cooperated with players in other industries" ($\alpha = 0.93$).

Attitude in the game. To assess attitude in the game, we presented two items: "I acted in the game with concern for the environment" and "I acted in the game for money."

3.4 Debriefing

After administration of the questionnaire, a debriefing session was held. Participants received snacks according to each individual's total assets in the game. The facilitators asked for their impression of the game, their own roles and the other industries, what aspects they paid attention, and what the purpose of the game was. Further, to share each participant's recognition, the facilitators talked about what was happening in the game and how the game proceeded. The facilitator also answered questions from the participants. Next, the situation of illegal dumping of industrial waste in Japan, the nature of a social dilemma problem, and the rules of industrial waste disposal in Japan were explained, followed by an explanation of the rules of the games associated with real-life rules. To facilitate deeper understanding of the game, we talked about how participants negotiated with each other, what happened in the game or the costs of production, intermediate treatment, and reclaiming landfill contents. Finally, to moderate conflict, we emphasized that players' behaviors were not always representative of their own personalities, but they were affected by the given structure including payoffs of the game and by other players' behavior. The debriefing took 15–30 min. After finishing the debriefing, the players voluntarily reallocated their sweets to share them equally, without encouragement from the facilitator. This indicated that the debriefing successfully de-roled the players and ended any residual conflict from the game.

4 Results

The amount of illegal dumping. To check differences between conditions or industries, a three-way analysis of variance (ANOVA: conditions $\times$ industries $\times$ sessions) using a mixed model including a factor for game was conducted on a session within participants and conditions and industries between participants. We analyzed the amount of illegal dumping as the outcome measure. There was a significant main effect of condition, showing that cooperative behaviors were more likely in the disclosure condition ($F(1, 200) = 3.05$, $p < 0.05$). A significant interaction was found between session and industries ($F(1,200) = 4.60$, $p < 0.05$). The more time that elapsed, the more the producing and intermediate treatment industries decreased the amount of illegal dumping, while the terminal industries dumped more illegally. However, checking by condition, more were dumped illegally in the control condition. Moreover, only one player engaged in illegal dumping in the final session in the disclosure condition, and this was caused by the rumor that he was dumping illegally. Upon hearing this rumor, he became angry and publically engaged in illegal dumping, despite not having dumped much illegally until then (Table 1).

Questionnaire. *The rates of sharing payoff matrix about other industries*; *benefit of product*, *cost of intermediate treatment*, *and landfill*. To compare the rates of the sharing payoffs between conditions, a chi-square test was conducted on the sharing rates of the payoffs of other industries. There was no significant difference in payoffs for product and intermediate treatment (product: $\chi^2(1) = 0.45$, *n.s.*, intermediate treatment: χ^2 $(1) = 1.15$, *n.s.*), but there was a significant difference in the payoffs for landfill (χ^2 $(1) = 9.47$, $p < 0.01$). Players in the disclosure condition knew more about the payoffs for landfill than players in the control condition (Table 2).

Collecting and disclosing information. We investigated whether players disclosed or collected information about bargaining and payoffs. There were marginally significant differences in information collection between conditions ($F(1, 37) = 4.85$, $p < 0.10$). In the disclosure condition, players collected more information. However, there was no significant difference in disclosing information ($F(1, 37) = 1.62$, *n.s.*) (Fig. 5).

Honesty on tracking sheets. We asked how the players reacted to tracking sheets. There were significant differences in both items "I reported on the tracking sheets honestly and I stamped them" ($F(1, 38) = 29.21$, $p < 0.05$) and "I felt a sense of obligation to report on tracking sheets honestly and I stamped them" ($F(1, 38) = 11.28$, $p < 0.05$). Players behaved more honestly on tracking sheets in the disclosure condition than in the control condition (Fig. 6).

The effectiveness of information disclosure. We investigated whether players felt the information disclosure was effective. There were significant differences in both items "I thought that disclosing information about bargaining or payoffs benefitted me" ($F(1, 38) = 9.11$, $p < 0.05$) and "Writing down the amount of commission facilitated our communication with each other." ($F(1, 38) = 80.46$, $p < 0.001$). Under the disclosure condition, more players thought that the disclosure of information benefitted them and facilitated their communication with each other than in the control condition (Fig. 7).

Cooperation with the same/other industries. We investigated the degree of cooperation with the same/other industries. There was marginally significant difference in cooperation with the same industry ($F(1, 38) = 6.23$, $p < 0.10$).

Table 1 The amount of illegal dumping

Conditions	Industries	Session1		Session2		Session3		Session4		Session5		Total	
		M	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD
Control	Producing	10.00	31.62	6.00	18.97	6.00	18.97	0.00	0.00	6.00	18.97	28.00	59.78
	Intermediate treatment	0.00	0.00	8.89	20.28	0.00	0.00	4.44	13.33	0.00	0.00	13.33	22.36
	Terminal	0.00	0.00	0.00	0.00	7.78	23.33	8.89	17.64	13.33	33.17	30.00	36.06
	Total	3.57	18.90	5.00	15.99	4.64	17.10	4.29	12.60	6.43	21.81	23.93	42.19
Disclosure	Producing	3.00	9.49	4.00	12.65	0.00	0.00	0.00	0.00	0.00	0.00	7.00	22.14
	Intermediate treatment	1.11	3.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	3.33
	Terminal	0.56	1.67	0.00	0.00	1.11	3.33	0.00	0.00	5.56	16.67	7.22	16.41
	Total	1.61	5.94	1.43	7.56	0.36	1.89	0.00	0.00	1.79	9.45	5.18	15.96
All	Producing	6.50	23.00	5.00	15.73	3.00	13.42	0.00	0.00	3.00	13.42	17.50	45.18
	Intermediate treatment	0.56	2.36	4.44	14.64	0.00	0.00	2.22	9.43	0.00	0.00	7.22	16.74
	Terminal	0.28	1.18	0.00	0.00	4.44	16.53	4.44	12.94	9.44	25.78	18.61	29.60
	Total	2.59	13.92	3.21	12.52	2.50	12.25	2.14	9.09	4.11	16.82	14.55	32.99

Table 2 The rates of sharing payoff matrix about other industries

Conditions		About producing		About intermediate treatment		About reclaiming in landfill	
		Knew	Didn't know	Knew	Didn't know	Knew	Didn't know
Control	*N*	9	9	12	7	8	11
	%	50.0 %	50.0 %	63.2 %	36.8 %	42.1 %	57.9 %
Disclosure	*N*	11	7	15	4	17	2
	%	61.1 %	38.9 %	78.9 %	21.1 %	89.5 %	10.5 %

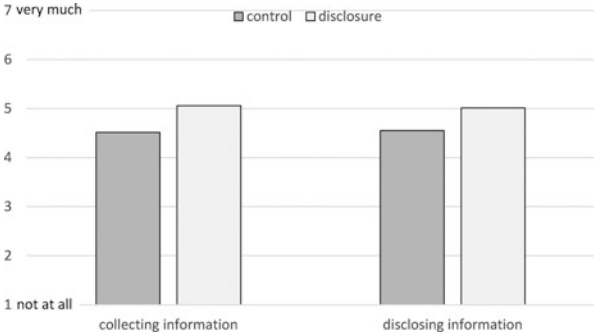

Fig. 5 The degree of collecting and disclosing information

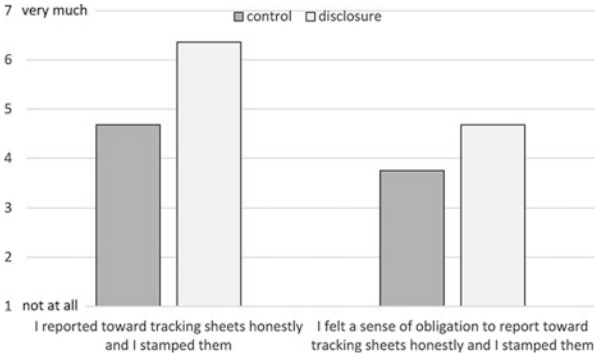

Fig. 6 The degree of the honesty on tracking sheets

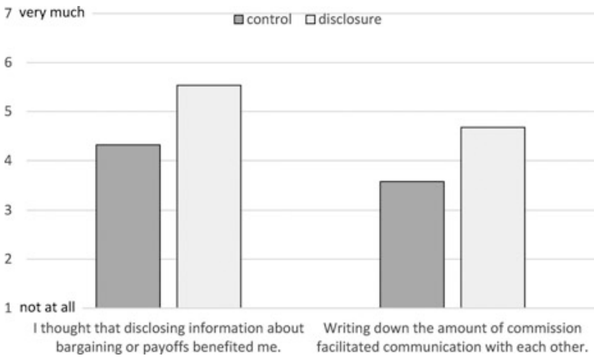

Fig. 7 The effectiveness of information disclosure

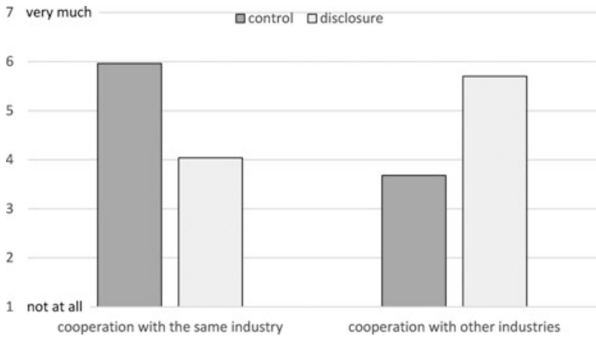

Fig. 8 The degree of cooperation with the same/other industries

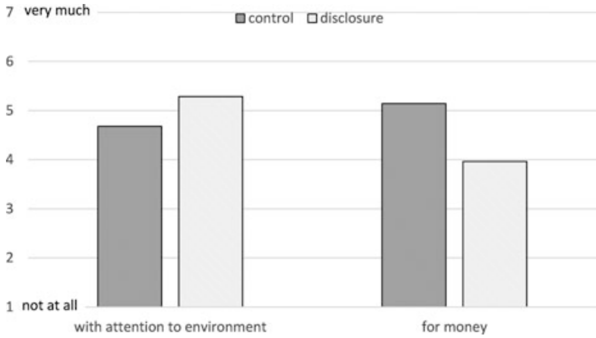

Fig. 9 Attitudes in the game

However, there was no significant difference in cooperation with other industries ($F(1, 37)$ =2.93, *n.s.*). Under the control condition, players cooperated more with others in the same industries than in the disclosure condition (Fig. 8).

Attitude in the game. We investigated which factors players paid attention to. The results showed significant differences. Players in the disclosure condition answered that they paid more attention to the environment ($F(1, 38) = 9.58$, $p < 0.05$) and those in the control condition reported they acted for money ($F(1, 38) = 7.30$, $p < 0.10$) (Fig. 9).

5 Conclusion

In this study, there were no penalties for incorrect descriptions on tracking sheets in the disclosure condition. In addition, anyone could fill out tracking sheets and no one could check their contents, so the incentive to provide correct descriptions was weak. This means the information on the tracking sheets was unreliable and hardly effective for surveillance. Nevertheless, filling out tracking sheets decreased non-cooperative behaviors. Players were active in information gathering and shared their information specific to each industry. In addition, they thought that filling in tracking sheets facilitated their communication.

The reasons for the results obtained can be explained by commitment and subjective norms. Commitment is defined as the degree to which one is bound or tied to a behavior by oneself (Keiseler 1971). Commitment affects subsequent behavior. Players made a social contract repeatedly during the game, although they filled in the tracking sheet after they made a decision about whether to treat the waste appropriately or engage in illegal dumping. Therefore filling in the tracking sheet worked as a form of commitment and had an effect on the behavior. The other possibility is due to subjective norms, which is derived from an expectation from significant others (Ajzen 1991). Players might feel subjective norms then become cooperative because they knew that the other players they had made contracts with were able to see the contents of the tracking sheets, even though they knew that it was uncertain for the other players whether the written information is accurate or not.

Suppose that writing the additional information on the tracking sheet has a function of increasing commitment and facilitating the perception of a subjective norms; if so we need to discuss more carefully the effects of communication. Both commitment and subjective norms require the existence of the other players, although the others do not surveil the player. The communication allowed between the participants was the same across the two conditions, that is, players in both conditions were able to communicate freely. Yet the framing, prior to discussion, was different in the two conditions. Kitakaji and Ohnuma (2014) argued that surveillance and penalty frame a situation as self-interest, while alternatively participants consider the situation as involving a common goal if sanctions are not present. Similarly, writing the amount on the sheet might trigger a norm of communicating with each other and thus promote communication and information sharing. We need to explore these possibilities further.

Finally, we need to consider the application of these findings for real society. This study does not propose that we should intentionally keep the recording of tracking sheets imperfect. However, we need to recognize that it will be impossible to adequately inspect all documents and all disposal processes in reality. Despite such limitations, it is notable that many industries comply with regulations and dispose of waste appropriately. We propose that since the recording of tracking sheets is an extremely complicated process and requires the active communication between industries, it serves as a means of promoting information sharing. This important function of tracking sheets must not be overlooked in any discussions about how to improve their functionality.

In summary, although they provide an imperfect system in terms of reliability, tracking sheets do serve to promote opportunities for information disclosure between industries. We should leave the decision on reliability of disclosed information to a disclosing party in order not to imply the strengthening of surveillance which might prevent people from sharing information. These results indicate that benefits can derive, even without any change to surveillance practices. Specifically our results indicate that it is not always necessary to make tracking sheets traceable for surveillance purposes, but rather they can be used to promote the sharing of information and the establishment of a sense of a shared common goal and subsequently enhance mutual cooperation.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179–211.

Armstrong, R. H. R., & Hobson, M. (1973). *Alea local government gaming-simulation exercise: Introduction to the York Bath Summer School Exercises*. London, England; Open University Press.

Asaoka, K., Tanikawa, N., & Baba, H. (2012). Sangyouhaikibutsu saisyuusyobunjou ni okeru manifesuto kisai jouhou no sinraisei no kentou no kekka oyobi kousatsu (Study on the reliability of information on the manifest of landfilled industrial waste in Japan), *Dai 23 kai Haikibutsu Shigen Junkan Kenkyuu Happyoukai Kouen Robunsyuu* (Proceedings of the 23rd annual conference of Japan Society of Material Cycles and Waste Management) (pp. 27–28).

Caldwell, M. D. (1976). Communication and sex effects in a five-person Prisoner's Dilemma Game. *Journal of Personality and Social Psychology, 33*(3), 273–280.

Dawes, R. M. (1980). Social dilemmas. *Annual Review of Psychology, 31*(1), 169–193.

Deutsch, M. (1958). Trust and suspicion. *Journal of Conflict Resolution, 2*, 265–279.

Deutsch, M., Epstein, Y., Canavan, D., & Gumpert, P. (1967). Strategies of inducing cooperation: An experimental study. *Journal of Conflict Resolution, 11*, 345–360.

Duke, R. D., & Geurts, J. (2004). *Policy games for strategic management*. Amsterdam: Rozenberg Publishers.

Gamson, W. A. (1978). *SIMSOC; Simulated Society participants manual with selected readings* (3rd ed.). New York: Free Press.

Hirose, Y. (1997). Kaso sekai geimu toha nanika? (What is SIMINSOC?). *Simyure-syonn sekai no syakai shinrigaku* (Social psychology in simulated society) (pp. 11–23).

Hirose, Y. (2000). Tagenteki genjitsu wo rikai suru medhia to shite no kasou sekai geimu (SIMINSOC as a media for communicating multiple realities). *Simure-syon ando geimingu* (Studies in Simulation and Gaming), *10*(1), 14–21.

Hirose, Y., Sugiura, J., & Shimomoto, K. (2004). Industrial waste management simulation game and its educational effect. *Journal of Material Cycles and Waste Management, 6*(1), 58–63.

Ishiwata, M. (2002). *Sanpai Konekusyon* (The industrial waste-connection), Tokyo: Wave Shuppan

Japanese Ministry of the Environment (2014). *Sangyouhaikibutsu no huhoutouki tou no joukyou (heisei 25 nendo) ni tsuite* (The situation of illegal dumping of industrial waste in 2013). Retrieved from http://www.env.go.jp/press/files/jp/25698.pdf

Keiseler, C. A. (1971). *The Psychology of commitment: Experiments linking behavior to belief*. New York: Academic.

Kitakaji, Y., & Ohnuma, S. (2014). Syakaiteki jiremma joukyou de hikyouryoku wo motarasu kansi bassoku – geimingu deno reisyou (Demonstrating that monitoring and punishing increase non-cooperative behavior in a social dilemma game). *Sinrigaku kenkyu* (The Japanese Journal of Psychology), *85*(1), 9–19.

Ohnuma, S., & Kitakaji, Y. (2007). Sangyohaikibutsu huhoutouki geimu no kaihatsu to syakaiteki jiremma apuro-chi: ritoku kouzou to jouhou no hitaisyousei to iu kouzouteki yoken ga motarasu kouka no kentou (Development of the "industrial waste illegal dumping game" and a social dilemma approach: Effects derived from the given structure of asymmetry of incentive and information). *Simure-syon ando geimingu* (Studies in Simulation and Gaming), *17*(1), 5–16.

Orbell, J. M., Van de Kragt, A. J., & Dawes, R. M. (1988). Explaining discussion-induced cooperation. *Journal of Personality and Social Psychology, 54*(5), 811–819.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.

Pruitt, D. G., & Kimmel, M. J. (1977). Twenty years of experimental gaming: Critique, synthesis, and suggestions for the future. *Annual Review of Psychology, 28*(1), 363–392.

Shubik, M. (1965). *Game theory and related approaches to social behavior*. New York: Wiley.

Thiagarajan, S. (1991). Garbage a card game that simulates the trade-off between competition and concern. *Simulation & Gaming, 22*(1), 112–115.

Van Vugt, M., & De Cremer, D. (1999). Leadership in social dilemmas: The effects of group identification on collective actions to provide public goods. *Journal of Personality and Social Psychology, 76*(4), 587–599.

Wit, A., & Wilke, H. A. (1990). The presentation of rewards and punishments in a simulated social dilemma. *Social Behaviour, 5*, 231–245.

Yamagishi, T. (1986). The provision of a sanctioning system as a public good. *Journal of Personality and Social Psychology, 51*(1), 110–116.

Yamagishi, T. (1992). Group size and the provision of a sanctioning system in a social dilemma. In W. B. G. Liebrand, D. M. Messick, & H. Wilke (Eds.), *Social dilemmas: Theoretical issues and research findings* (International series in experimental social psychology, pp. 267–287). New York: Pergamon Press.

Cormas: An Agent-Based Simulation Platform for Coupling Human Decisions with Computerized Dynamics

Pierre Bommel, Nicolas Becu, Christophe Le Page, and François Bousquet

Abstract This chapter presents the new functionalities of Cormas, a generic agent-based modeling (ABM) platform dedicated to common-pool resource management. As free software, Cormas is used by an international community of researchers willing to understand the relationships between societies and their environment. It is intended to facilitate the design of ABM as well as the monitoring and analysis of simulation scenarios. Cormas has taken an innovative direction oriented toward the collective design of models and interactive simulation. In accordance with the principles of participatory methods and serious games, many experiments developed with Cormas combine two layers of complexity: the natural dynamic of the system, simulated by the computer, and the stakeholders' interactions and decisions played by the actors. Between these two extremes, a range of intermediate situations exists where some decisions are human and others are computer specified. The term hybrid agent simulation covers these intermediary situations. The main idea is to enable the stakeholders to interact with the execution of a simulation by modifying the behavior of the agents and the way they use the resources. Thus, it is possible to collectively explore scenarios to better understand how a desired situation may be reached. This may feed back into the collective design of the model. As our intention is to involve more deeply the stakeholders into the modeling process, it is necessary to have an easily changeable tool to act on the simulation and to modify the conceptual model on the fly. After having explained the purpose and the philosophy of the companion modeling, this chatper presents how the Cormas functionalities (asymmetry of information, agent manipulation, modification of behavior, stepping back, and distributed simulation) are put into practice through three experiments with stakeholders facing actual environmental challenges.

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Keywords Participatory modeling • Interactive simulation • Natural resource management • Stakeholders' involvement • ABM

1 Introduction

Cormas (for common-pool resource and multi-agent systems) is an agent-based modeling (ABM) platform dedicated to natural and common-pool resource management (Bousquet et al. 1998). As an open-source and free software, it is used by an international community of researchers (Le Page et al. 2012) willing to understand the relationships between societies and their environment. Cormas is intended to facilitate the design of ABM as well as the monitoring and analysis of agent-based simulation scenarios. Indeed, the purpose of ABM is to understand how independent entities can interact, can be coordinated, and may coevolve while producing effects on the system as a whole. An agent can be described as an autonomous entity that has the capacity to adapt when its environment changes, and conversely his actions may modify the environment. A multi-agent system is made up of a set of entities that act at the same time, i.e., several agents that perform activities, share common resources, and communicate with each other. As they are centered on entities, ABMs enable the user of a simulation to assume the role of an agent and, for example, to "think like a wolf, a sheep or a fly" (Wilensky and Reisman 2006). In order to deal with renewable resources, Cormas is mainly oriented toward the representation of interactions between stakeholders and their environment with a specific focus on the interactions between natural and social dynamics.

From recent years, the development of Cormas has taken an innovative direction more oriented toward participatory modeling, i.e., collective design of models and interactive simulation. This new orientation has been taken to meet the increasing demand of our community of practice. Indeed, in parallel with the development of Cormas, a modeling methodology called the ComMod approach (for companion modeling) has been set up and formalized (Barreteau et al. 2003; Etienne 2011). If the classic use of simulation is for prediction, this is not the option we have chosen because the long-term economic and social future cannot be predicted, although it can be partially decidable. We assume that stakeholders can "decide" long-term objectives on the basis of a shared conception of how the present situation should evolve. It is thus possible to explore scenarios collectively to better understand if the desired situation may be reached. The underlying model depends on the way the actors are represented. Two major types of representation can be distinguished: (i) virtual agents performing predefined activities in a computerized ABM or (ii) human agents playing their role in a role-playing game (RPG). Even if it is not in the classic sense, an RPG can be seen as a representation of the world, i.e., a model. But between these two extremes, a range of intermediate situations exists where some decisions are human and others are computer specified. The term hybrid agent simulation model covers all these intermediary situations (Le Page et al. 2014). The mediation approach presupposes that the stakeholders are well informed of the issues dividing them and of the fact that they all have an interest in solving the original problem.

For that purpose, we are developing Cormas toward two directions: (1) to facilitate the collective design and implementation of ABMs and (2) to enable the development of interactive simulations in order to let the users participate actively, alone or with others, in the execution of a scenario. As a generic framework, Cormas allows the modeler to specialize and refine predefined entities for his own model. But this new version is particularly suitable for:

- Changing the parameters of one or a set of agents of a running simulation
- Manipulating an agent directly with the mouse on the computer: moving him on a precise location, sending him specific messages, or even designing new behaviors, thanks to an activity diagram editor that is directly interpreted by the agent
- Stepping back in time of a simulation and restarting the interactive simulation to a previous state (bifurcations) or replaying forward a previously stored simulation
- Distributing a simulation on several machines, monitoring the evolution of a remote simulation, and remotely manipulating the entities
- Displaying particular points of view of the simulated landscape, opening several zooms, and enabling specific "habitus" for the available points of view

Our intention is to involve more deeply the stakeholders into the modeling process. Because if adaptive management has become a buzzword, in practice people's participation is often just a catchy expression used by scientists to justify the process of extracting information (Voinov and Bousquet 2010). On the contrary, true participation should encourage producing models that are able to promote mutual recognition of perceptions, knowledge appropriation, and finally collective decision-making. For this it is necessary to have an easily changeable tool to act on the simulation and to modify the conceptual model on the fly. Our various field experiments have shown the need to create continuity between the conceptual model and its implementation. We hope this new version will contribute to achieve this goal.

2 Cormas' Overview

As a framework that proposes predefined classes and a set of visualization tools, the Cormas environment is intended to facilitate the implementation of ABM as well as the monitoring and analysis of simulations. It uses VisualWorks (Brauer et al. 2015), a programming environment based on Smalltalk, one of the first purely object-oriented languages. A framework means that the modeler implements its model by specializing predefined classes in Cormas. These general classes contain attributes and generic methods that can be reused by the specialized classes.

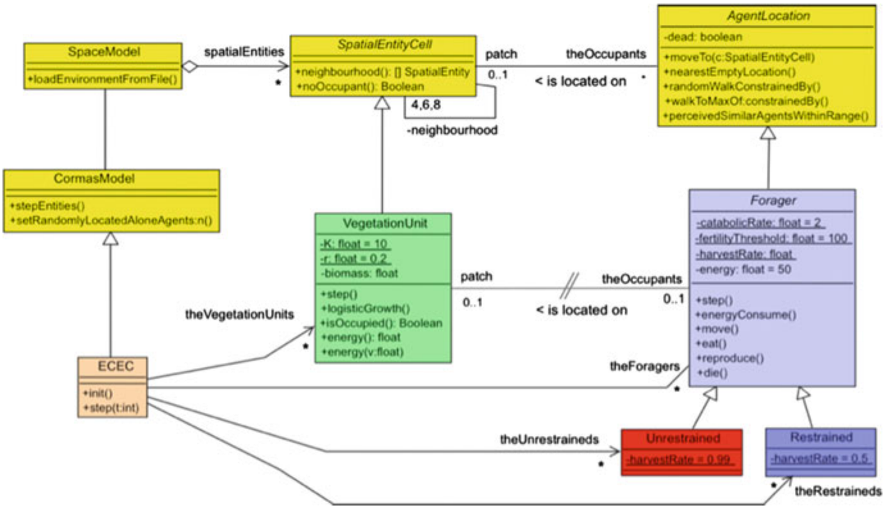

Fig. 1 UML class diagram of the ECEC model, adapted to Cormas (implementation stage). The *yellow* classes belong to the framework and the other (*colored*) classes are for the ECEC model

Mainly, three generic types of entities are available: the “social agent” group, the “spatial” group, and the “passive entity” group that contains the other kinds of entities such as messages, land covers, strategies, etc. Thus, when creating a specific agent (e.g., a Forager), the modeler can define it from the “AgentLocation” generic class. This new agent will be automatically registered by the scheduler and will be also able to move on the space or to perceive his neighbors by calling the generic methods (#moveTo: and #perceive) defined at the level of the AgentLocation superclass. The following class diagram presents how a simple model with two kinds of entities (VegetationUnit and Forager) is designed into Cormas (Fig. 1).

One tutorial is based on this simple model called “ECEC.” It is a model by Pepper et al. (2000) that was replicated into Cormas. As it specializes AgentLocation, the Forager class inherits from useful methods predefined into its superclass such as #nearestEmptyLocation or #moveTo:. They allow any instance of Forager to perceive the free places around him and to move to a target place. These generic methods can then be reused in the #step method to specify the global behavior of the agent. CormasModel is the abstract scheduler of the model and is in charge of the overall control of the dynamics. Here, it is specialized by the ECEC class that can reuse many predefined methods for instantiating the initial state of a simulation and for activating the entities. The ECEC class contains three attributes, each one pointing on a list of the instances of the three concrete classes of the model (the green, red, and purple classes). In Cormas, these attributes are set automatically when creating the classes of the model, and the lists of instances are updated during a simulation (by removing the dead agents and adding the new ones).

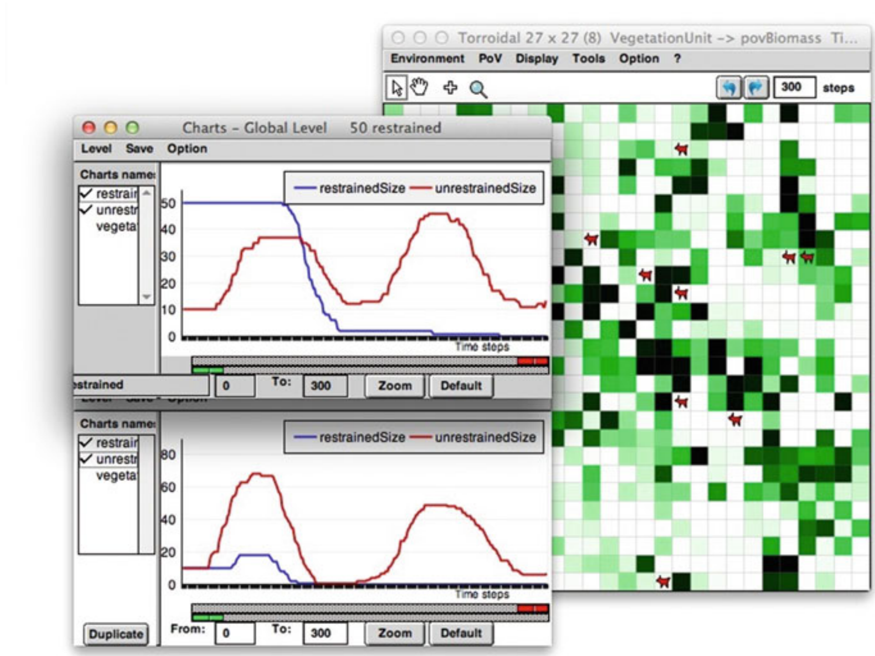

Fig. 2 The spatial grid displaying the biomass viewpoint of the vegetation (*right part*) and two chart interfaces showing the evolution of the populations of foragers: the *upper chart* presents a simulation with 50 initial restrained foragers when the *lower one* starts with ten agents

The advantage of using a platform is also that it frees the modeler from many coding constraints. As Cormas complies with the MVC architecture,[1] it allows the modeler to focus solely on his subject without worrying about the accessories that come with a simulator. After having coding the agents and the other entities of his model, the modeler must simply specify the way the entities are activated by the scheduler. Finally, he can specify the way he wants to visualize the entities and the probes of his model. For this phase, several interfaces are available that prevent the modeler to code the model display and the curves of the probes (see Fig. 2).

When the implementation is done, some simulations can be run. A spatial grid can be opened showing the virtual landscape and the agents. Various ways of displaying them can be selected by the user in order to see the virtual word from different "points of view."

[1] MVC for Model-View-Controller is a model for software architecture that specifies a clear separation between the code of a model and how to visualize and manipulate it. This architectural model was designed in 1979 by Trygve Reenskaug (Reenskaug et al. 2003), who was working on the design of Smalltalk with Alan Kay, Dan Ingalls, Ted Kaehler, and Adele Goldberg at the Palo Alto Research Center of Xerox.

Finally, the modeler can run analyses by setting three types of sensitivity analyses: simple stochastic analysis that repeats several simulations, OAT analysis (one factor at a time) to study the signature of the parameters (the value of a parameter is gradually or randomly changed for each simulation), and crossed analysis for which several parameters' values are changed simultaneously. The data of these analyses (recovered as time series, average over a simulation, min or max on a period) are saved in CSV or Excel format.

3 Participatory Modeling to Support the ComMod Approach

From recent years, the development of Cormas is more focused on participation. This means that Cormas has taken an innovative direction toward the collective design and the interactive simulation of ABM. This new orientation has been taken to meet the increasing demand of our community of practice.

In parallel with the development of Cormas, the ComMod approach (Etienne 2011; Bousquet et al. 1996; [Collectif ComMod] Bousquet et al. 2009; Gurung et al. 2006) has been set up and applied in many countries. "Companion" means that the aim is to help the stakeholders in defining their own long-term objectives, to "accompany" them, instead of proposing a "turnkey" formula for resource management (Bousquet 2005). In this complex field, it seems necessary to take some distance with the positivist posture that designates the scientific knowledge as the only accurate one. In contrast and following in the footsteps of the constructivist epistemology (in the sense of (von Glasersfeld et al. 1999; Le Moigne 1995)), the ComMod approach seeks to collectively "construct" knowledge on the basis of the stakeholders' perceptions and their social experience. Beyond traditional decision support systems, this participatory approach is based on the construction of a shared conception of how the participants perceive the present situation and how it could or should evolve. As a mediation approach, ComMod presupposes that the stakeholders must be well informed of the issues and that they all have an interest in solving the original problem.

To better understand the present situation of a given system, the collective design of an ABM is carried out in order to seek a mutual recognition of everyone's representation. In such a context, the modeling process is more a communication platform to facilitate collective learning than a predefined itinerary for piloting resources (Le Page et al. 2013). To facilitate this difficult phase, the use of role-playing game (RPG) is often proposed in which the participants play their own role in a virtual and simplified situation. Even if it isn't in the conventional sense of the word, an RPG can be already seen as a representation of the world, i.e., a *model* (Daré and Barreteau 2003). The discussion on the game during the debriefing helps to confirm or revise some parts of this conceptual model.

RPGs involving local stakeholders enable representing context-specific situations of given social-ecological systems. In a gaming session, a participant who plays his own role provides information that helps to specify the behavior of the corresponding computer agent (Barreteau et al. 2003; Bousquet et al. 2002). This approach is now well recognized in empirically based ABM (Janssen and Ostrom 2006): behaviors exhibited during the gaming session and the decisions made by the players are used to specify rule-based methods for the computerized agents (D'Aquino 2003). Yet, the formulation of generalizable decision-making algorithms may be difficult for participants who tend to focus on their peculiar situation: as an individual, it may be difficult to think in terms of behaviors representative of a group of individuals.

In a second phase and from the conceptual model, an implemented ABM offers the possibility to explore scenarios collectively. Because and contrary to what one might expect, the design of an ABM does not immediately give access to understanding of its behavior. Indeed, time in ABM plays an active and decisive role by activating the entities progressively. The sequence of activities and interactions can often produce surprising outcomes hardly predictable. Even if the elementary mechanisms are simple, we are not able to take into account many elements that influence each other at the same time (Deffuant et al. 2003). Thus, the simulation helps to understand the functioning of the system and to assess if the evolution of the virtual system is coherent with the real one. By confronting the common perception of the system with its virtual evolution, the simulation helps to correct the conceptual model in order to be more compliant with the actual situation.

The underlying model for the simulations depends on the way the actors are represented. Two major types of representation can be distinguished: (i) virtual agents performing predefined activities in a computerized ABM or (ii) human agents playing their role in an RPG (as previously said, ABM and RPG both are types of models that characterize a situation). Between these two extremes, a range of intermediate situations exists where some decisions are human and others are computer specified. The term hybrid agent simulation model covers all these intermediary cases (Le Page et al. 2014).

4 The New Functionalities of Cormas, Oriented Toward Participative Design and Simulation

Instead of watching a simulation without interfering with the process, an interactive simulation aims at evaluating different decisions taken by the agents. For that purpose, the participants can change the parameters or can also send specific orders or even modify the main strategy of an agent. By interacting with the virtual system through "avatar" agents, the participants can test alternative strategies or new practices to assess their consequences.

The works recently undertaken on Cormas are consistent with this participatory approach oriented toward collective prospective. Some new tools are now available that allow the participants to actively contribute in the design of an ABM and to interact with the simulator. The users can define indicators that meet their requirements and choose to observe the simulation through specific filters (called "points of view"). Because they are often spatially distributed, it is also possible to see just a part of the space (usually the one that concerns the participant). The users can also interact directly with their avatar (supposed to represent them) by moving them or sending instructions to use, for example, the water resources or to change the land cover. It is also possible to provide a set of core activities from which the user can shape a new strategy. Thus, with these new tools, the modeler no longer describes the overall behavior of the agents but provides basic activities that the participants can use to interact with the environment and the other agents. Because these interactive simulations can also be distributed on networked computers, multiple users can interact on the same virtual environment. The objective is not to have distributed simulations on the Internet, but to interact within the same room: this proximity between the users facilitates direct interaction and nonverbal communication. These tools for interactive modeling are based on concrete experiences with ComMod, and some new works are still in progress to cater for the growing needs of recent study cases.

4.1 Designing a Model

As Cormas is a framework, the modeler has to specialize some predefined classes, mainly "social," "spatial," or "passive" entities. When designing a specific class, its attributes must be specified. Cormas assists the modeler in setting the initial value of these attributes. The capture in Fig. 3 presents the initial value of the "energy" attribute of the Forager class (see Fig. 1). It is set to 50 energy points by default. It means that at the initialization of a simulation, all the foragers start with 50 energy points. And during the simulation run, each new instance of Forager will have also 50 points. But the default value can be easily changed. To test the effect of a new value, a table presenting all the numerical parameters allows the user to modify them temporarily. For example, it is easy to change the initial number of restrained foragers as shown in Fig. 4.

Thus, to compare the two distinct simulations, a copy of the previous curves can be displayed (see Fig. 2). At the initialization and also during the progress of a simulation, the scheduler automatically registers all the new instances and removes the destroyed ones.

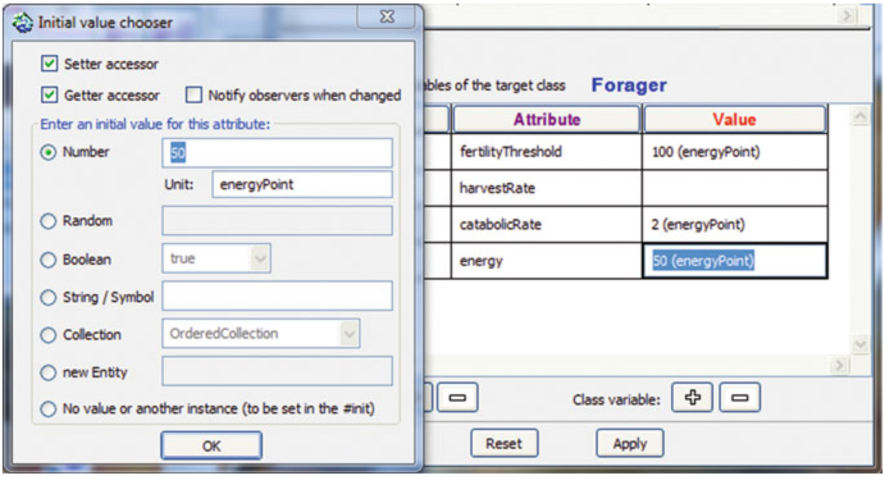

Fig. 3 Interfaces to set attributes and their default values

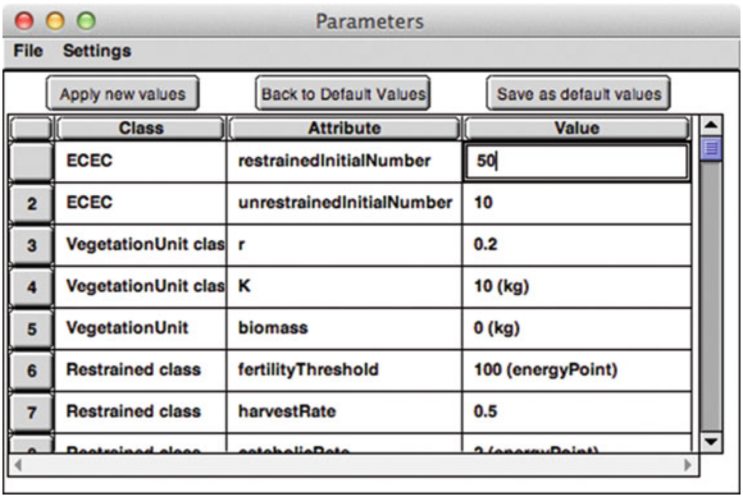

Fig. 4 Table of the numeric attributes

4.2 Multi -windowing for Displaying the Agents

As Cormas complies with the MVC architecture, it is possible to visualize the spatial environment through several windows. Because the model is independent from the way to see it, one can select various points of view (PoVs) to display (or not) the entities. In the PoV menu of the spatial grid, some specific PoVs are available for each class of the model. By default, three PoVs are proposed: “nil” that doesn’t display the instances of the class, “defaultPoV” for which a standard

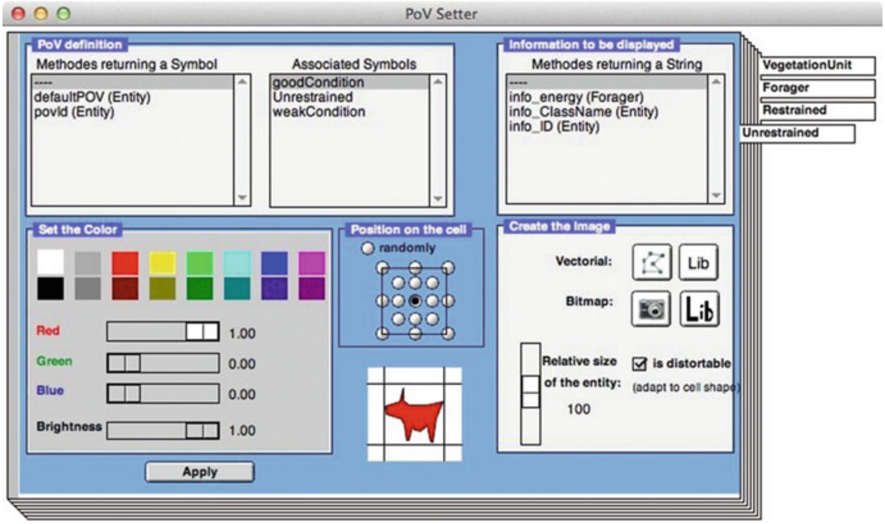

Fig. 5 The PoV setter presents the *povState* of an Unrestrained Forager in “goodCondition”

figure (or color) is available, and “povId” that displays each entity with a different color. But it is easy to draw specific PoVs, thanks to the PoV setter interface. In the following interface, *povState* has been drawn to display the animals in good or weak condition (energy <20). Thus, by selecting *povState*, the figure of each forager is displayed according to its current condition (Fig. 5).

It is also possible to open another spatial grid and to select different PoVs in order to see two different viewpoints simultaneously. The zoom tool will open a third window displaying just a part of the grid (selected by the user). Some information can be displayed (e.g., the biomass value of each cell), and by using a contextual menu on an agent, this one can be tracked. The following screenshot shows a view on the full spatial grid (left part) and two zooms on the same region visualized with different viewpoints (right part) (Fig. 6).

4.3 Manipulating the Agents

To interact with a simulation, it is possible to modify the parameters’ value of the entities (as shown in Fig. 4). But it is possible to act directly on the space and on the agents during the simulation. There are mainly two ways of acting: either on all entities simultaneously or on some specific ones. In the first case, we can change the state of a group of agents or create new ones (Fig. 7).

In the second case, the “manipulation” tool allows the user to control an agent individually by moving him on another place or by sending to him some messages. Indeed, right-clicking on an agent opens a contextual menu that offers the

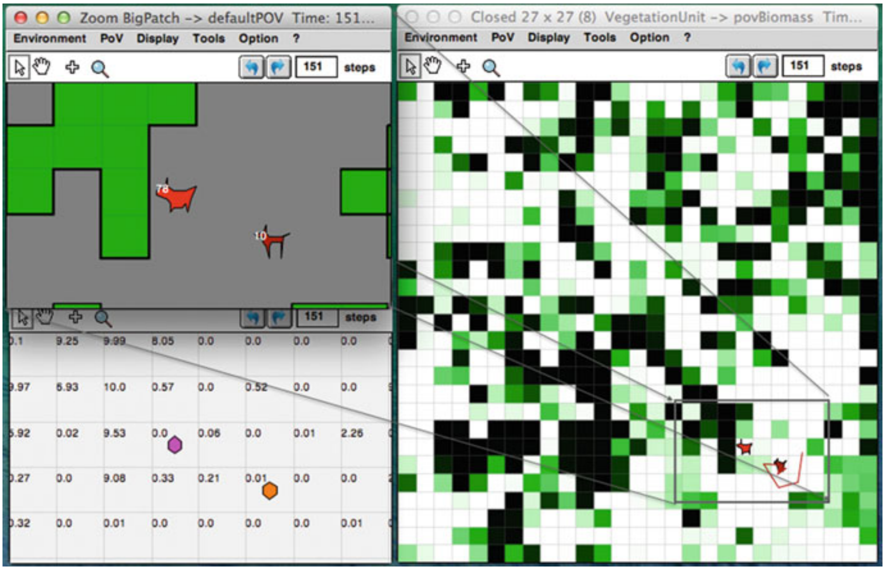

Fig. 6 A screenshot of the full spatial grid (*left part*) and two zooms on the same region visualized with different viewpoints (*right par*t). The forager agents are displayed with *povState* or *podId*; the weakest is tracked on the *left* part and their energy level is revealed on the upper *right* grid

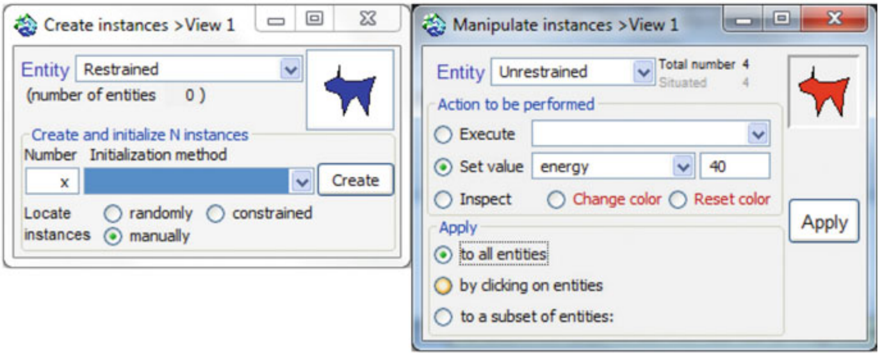

Fig. 7 Manipulation interfaces, one to create new instances (*right*) and the other to execute action or to change attributes' value of the agents

possibility to select a message in an automatic scrolling list containing all the available methods of the class and subclasses of this agent. The following screen capture shows two ways to send messages to an agent: (left) preselecting the message that will be executed by each agent "Unrestrained" clicked by the user or (right) clicking on an agent and then selecting a method from the list to be performed (Fig. 8).

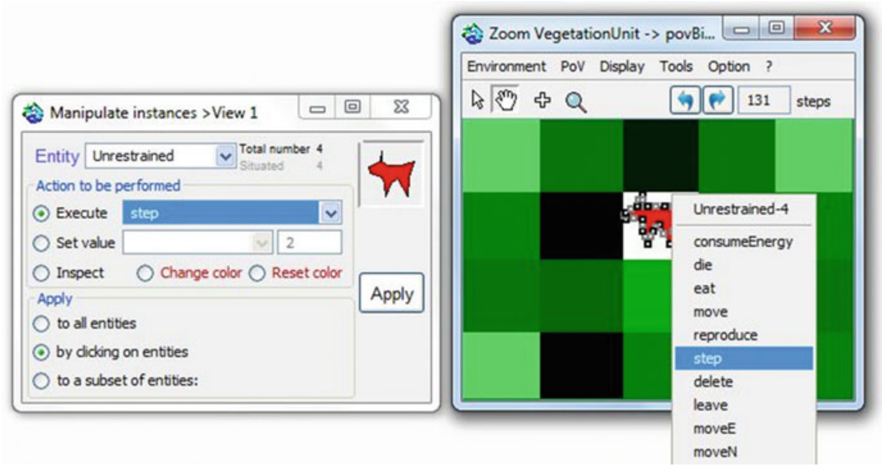

Fig. 8 Two ways to send the "step" message to an agent in Cormas: (*left*) preselecting the "step" message that will be executed by each clicked agent or (*right*) clicking on an agent and then selecting the "step" method from the list to be performed

4.4 "Habitus": Customizing the Interfaces

Lately Cormas has been enhanced with a feature that enables customizing the spatial interface that fits specific ways to perceive and interact with the entities represented in the model. This feature is based on the concept of habitus defined by Bourdieu as the set of ways of being, feeling, acting, and thinking that are proper to an individual (Bourdieu 1980). This concept is especially interesting because following Bourdieu, a habitus structures the behavior and the actions of the individual while also structuring their position in a multidimensional social space. Hence, when developing an RPG, the habitus feature of Cormas will guide the modeler in structuring the position of the different roles in the space of the socio-ecological interactions of the system. Defining a habitus in Cormas consists in defining (1) how users can see the space interface, what entities are displayed and in which way, and what information is available (textual information or tracking agents) and (2) how they can interact with this interface (what kind of entities can be created and what type of actions the users can ask an entity to be executed, to move, to consume, to slash-burn, etc.). The habitus configuration interface (Fig. 9) is divided in two main parts: the observation and the manipulation of the entities. With the first part (top of the interface), the modeler can specify for each entity what PoVs can be accessed by the user, as well as the default PoV that must be displayed when opening the space interface for the first time. The same applies for the textual information to be displayed for each type of entity, as well as for the attributes and the probes that can be inspected. Playing with these configuration settings allows the modeler to develop very different ways to visualize and access the information about the simulated socio-ecological system.

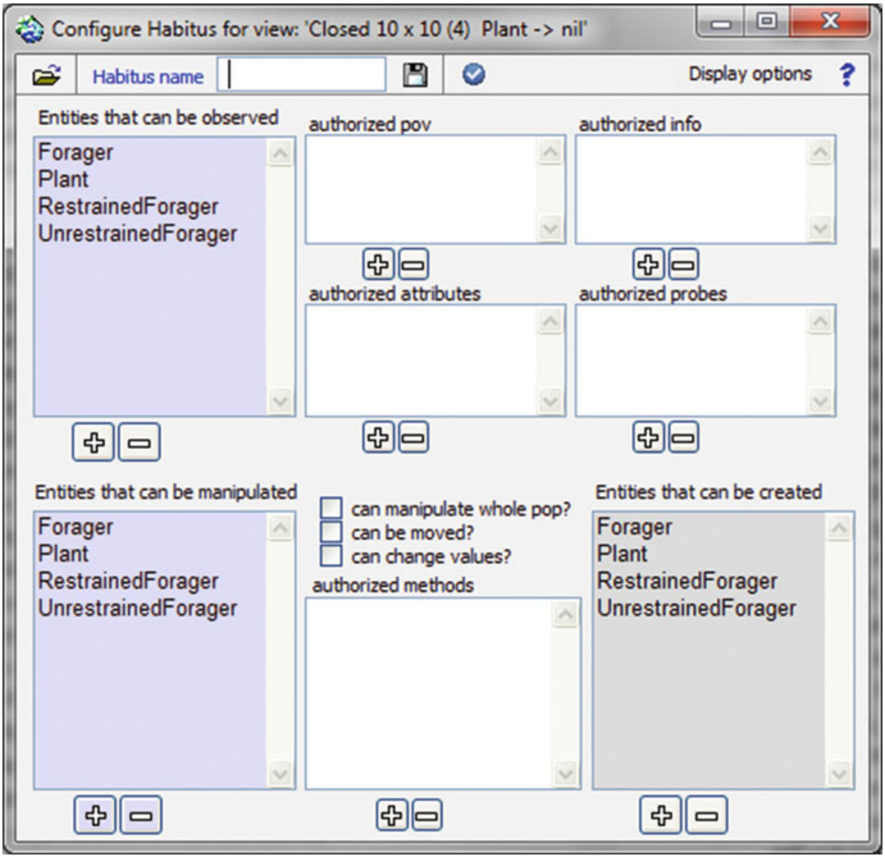

Fig. 9 The habitus interface to restrict the option to visualize the entities (*top part*) and the control on them (*bottom part*)

The second part of the habitus configuration interface (bottom part) allows the modeler to customize the list of operations to control an agent. If by default all the operations are available, the list of control will most often be different from one habitus to another, restricting the possibilities for each user in an asymmetric manner (see Sect. 5.3). Hence, for instance, we can develop two configuration settings: one for a user to control the grazing of a forager and a second for another user to control its reproduction. In the same idea, the modeler may customize the type of entities that can be moved or created, directly through the space interface during a simulation run.

4.5 Distributing the Views for Interactive Simulation

In Cormas, a simulation can be distributed on several machines. This means that several users can remotely monitor the same simulation (with different viewpoints) and can remotely manipulate entities.

The distribution architecture in Cormas does not comply with the IEEE standard for common war games across worldwide host computers. As this standard is much dedicated to real-time distributed applications by the commercial and military gaming industry, our goal is not to resolve complex dead-reckoning processes to enable massive online simulation.[2]

As Cormas is based on the MVC architecture, the distribution is not completely duplicated on each computer, but only the views and the controllers. In that case, only one computer runs the simulation (the server), and the other connected computers (the clients) display some specific points of view on the virtual environment and provide limited control on the simulation (according to the habitus). The remote visualization enables multiple users to manipulate their agents and to act collectively on the same virtual environment.

Even if a simulation can be distributed on the Internet, we prefer to use this ability on networked computers within the same room. For us, physical proximity is important as it allows the users to interact directly by talking to each other or by nonverbal communication.

4.6 Executable Activity Diagrams

Cormas offers an editor that enables the drawing of simple activity diagrams. During a simulation, these diagrams are executed directly by the agents, without any need for translation into code. These diagrams are interpreted "on the fly" by Cormas. Thus, it is possible to modify the behavior schema of an agent without coding it. It is also possible to modify the simulator while it is running, without stopping or restarting the simulation.

For simplicity sake, the elements available on the editor are restricted to initial and final nodes, decision points, simple activity nodes (without parameters nor ability to handle an activity output), and transitions. A decision point authorizes only two transitions to come out of it, indicating the fulfillment (true) or the negative answer (false) of a decision test.

By selecting an activity node or a decision point on the tool bar, the user can add a new element on the diagram. Then, he must choose the operation to be performed by selecting it from an activity chooser. This one displays a list of operations belonging to the target class and its superclasses. Therefore, the user can draw a transition from the given node to another. Two transitions start from a decision point: one for which the answer of the decision test is true (green) and one for false (red). Thus, from basic operations already defined by the modeler, anyone may generate new upper-level behavior without any programming skills.

[2] In order to save bandwidth and to avoid the lag effects, dead-reckoning (for deduced reckoning) estimates the current position of an entity by using the previously detected position and by calculating the new position based upon known or estimated speeds over elapsed time and course.

This editor does not avoid the modeler to program his ABM. Its objective is rather to collectively design the behavior of an agent by organizing plug-and-play activity nodes. These activities contain pieces of code (software bricks or components) that were previously coded by the developers.

Because it is intended for nonspecialists, the editor has been designed to be as simple as possible. For that reason it does not contain sophisticated features such as swimlane, iteration, and concurrency notations that are nowadays specified by UML 2.0 (OMG 2005). In return, this simplicity enables anyone to participate more actively in the modeling design with greater efficiency, thanks to the immediate assessment of any changes (Fig. 10).

The executable editor operates differently than the standard "Executable UML" (xUML) (Mellor and Balcer 2002; OMG 2008), which specifications require the translation of a diagram into code by executable UML compilers. Conversely in Cormas, an activity diagram is not compiled into code but is directly interpreted by the agents. In other words, a new activity diagram is saved as part of the source code of an ABM. It can be reopened at any time, modified, and performed without compilation. By taking advantage of the Smalltalk facilities (a reflective programming language, dynamically typed), it is possible to modify the diagram of an agent while the simulation is running. As soon as the modified diagram is saved, the agent begins to perform his new behavior. This specificity can be useful when a user who is observing a trend of a simulation wants to test how a change of the agent behavior could modify the direction toward where the simulation is going.

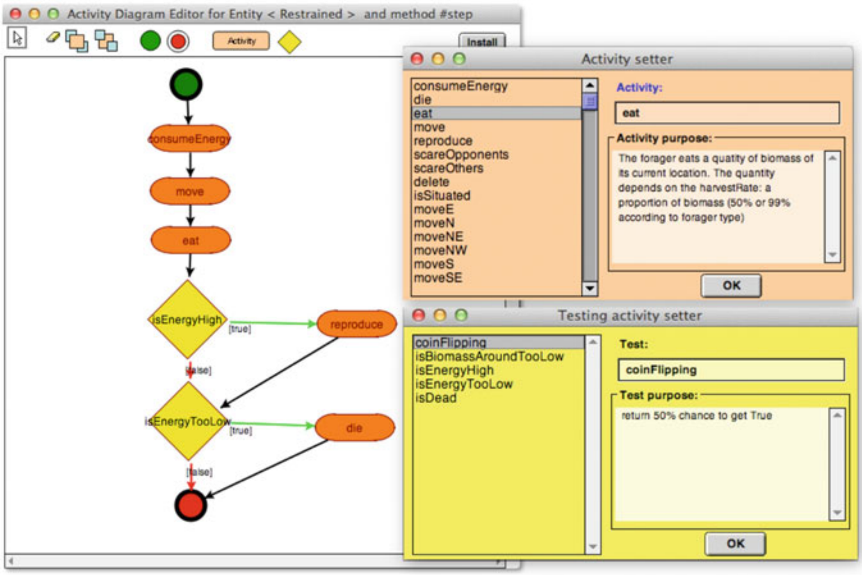

Fig. 10 The executable activity diagram editor. Example on the main behavior of Forager (ECEC) with two activity setters

4.7 Time Travel Simulation: Stepping Forward and Backward in Time

If the simulation dynamic is commonly done by time step forward in time, Cormas enables also to navigate backward in time. As reverse-time calculation is mathematically unfeasible, Cormas does not simulate in reverse when stepping back. Therefore, to enable the step back capability, a previous forward simulation must be run to save snapshots. Thus, a click on the back button is merely a means of returning to the previously stored state. Thus, one can go forward or backward to a particular instant in simulation time by restoring a recorded state.

The step forward and back facility helps to analyze model and to verify if its mechanisms behave as expected. When trying to understand a strange behavior of a model, the user can return back to a specific moment just before the unclear period and, as for a movie, restart from that state to follow slowly how and why the entities act in such a way. But from that particular state, it is also possible to run a new simulation step by step to check if the entities behave similarly or if the system evolves in another way (called time bifurcation, see Fig. 11).

Because a standard instantiation of a simulation may create artifacts (e.g., all agents with same age), it is practical to run the system for a moment until a balanced

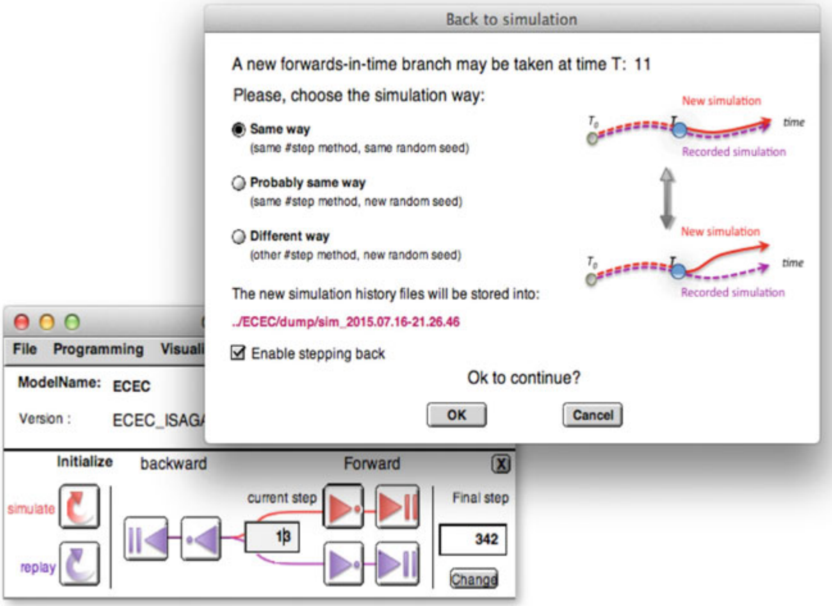

Fig. 11 *Bottom*: the main interface of Cormas with the "Simulate" (*red*) and "Replay" (*purple*) buttons. *Top*: the time bifurcation interface to start again simulating from a recorded state

state. Then, this current state can be saved to provide the starting point for future simulations.

Finally, the snapshot and restore ability is used when manipulating the agents: undo and redo buttons are available on the spatial grid to cancel a user action or to reactivate it.

5 Putting into Practice

5.1 Interactive Simulations to Codesign with Villagers an ABM on Bush-Meat Hunting in the Periphery of Korup National Park (Cameroon)

An ongoing project in the periphery of the Korup National Park (Cameroon) aims at helping the local population in managing the wild fauna, especially the overexploited animals hunted for their meat for personal consumption and for money. For that purpose, an early and interactive use of a stylized scale model was achieved with hunters in villages at the periphery of the park (Le Page et al. 2015).

One of the challenges to design the model was the formulation of decision-making algorithms for the hunting activity. Two sets of workshops were organized in villages of the study area to introduce the spatially explicit individual-based module of the main hunted species (the blue duiker, *Cephalophus monticola*, a small forest antelope) and then to elicit and specify the hunting practices of participants through collective discussions during the presentation of the computer simulation model. A three-step exercise was carried out in order to facilitate the comprehension of the computer model among participants. The first step was meant to introduce the abstract representation of a village in the forest and the blue duiker individual-based population module. The different types of land cover and the notion of cell as a 1-ha portion of space were presented, as well as the seven colors used to represent the various stages of individual blue duikers. In a second step, hunting with traps was introduced in a wider portion of forest (two villages linked by a road, a stylized map still without any realism). The last step was built on the elements previously introduced but was based on an explicit representation of the seven villages and the Northern periphery of the Korup National Park. The whole portion of space represented in the model was gradually expanded: 1.5 km * 1.5 km in the first step, 5 km * 5 km in the second step, and 16 km * 18 km in the last step. This process of zooming out allowed starting focusing on the biology and the behavior of the blue duiker. The objective was to communicate and to discuss the related parameters and the underlying assumptions for the participants to not

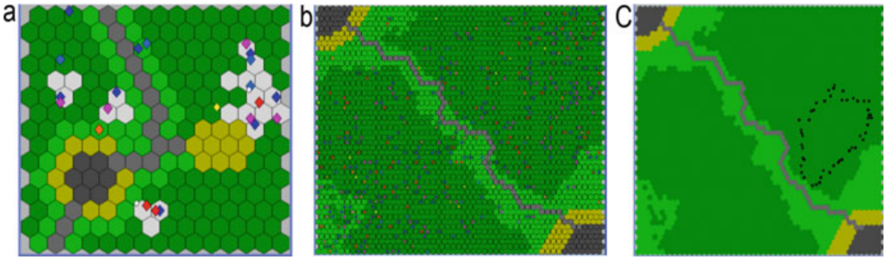

Fig. 12 (**a**) In a schematic representation of a village (*dark gray*) crossed by a road (*light gray*) and surrounded by agricultural fields (*brown*) in a forest (secondary in *light green*, primary in *dark green*), the various stages of antelope agents are displayed: adult (gravid females in *pink*, females in *red*, males in *dark blue*), subadult (males in *light blue*, females in *orange*), juvenile (in *yellow*), and newborn (in *white*). When a couple of adults have mated, they establish a 3-ha territory (three very light *gray* cells) and exclude other adult antelopes to settle and reproduce there. (**b**) The spatial representation is zoomed out to display two villages connected by a road. In the forest, a population of antelope agents is created with a local density proportional to the distance to the nearest village. (**c**) Results of a trap-path set interactively by a participant

consider the model as a black box and to become familiar with it. In the final step of the workshops, the more realistic representation of the region in the model allowed making the final discussions more concrete. During the first stages of the workshops, the functionalities of the Cormas platform to interactively modify the attributes of the spatial entities (forest portions) and to directly create and manipulate located entities (animals and traps set by hunters) were used to display easy-to-follow configurations open to collective discussions (see Fig. 12).

5.2 Codesigning the Strategies of Bovine Breeders by Using Executable UML (Uruguay)

The livestock sector plays a central role in the economy of Uruguay, which has the world's highest number of cattle per capita (3.8). Because of severe droughts that affected the north Uruguayan region in the last decades, we initiated a project to improve the adaptation capacities of livestock farmers. Indeed, in the late 1990s, livestock breeders experienced severe droughts provoked by climate change: millions of animals died or had to be slaughtered prematurely causing numerous bankruptcies. If certain farmers were less affected by these extreme situations, it was unclear how they worked exactly and which strategy was better in the long run.

To test different breeder strategies and to facilitate the communication among farmers and support services, we have built an ABM of livestock producers. The first step is more standard since it consists in implementing an ABM with pasture growth, herd dynamics, and simple agents roughly imitating farmers' strategies (Dieguez Cameroni et al. 2014). This first version was presented and discussed with livestock breeders during several workshops. The main criticism concerned the over simplistic behaviors of the agent that makes his decision by looking solely at the pasture height or at the cattle health. It was therefore requested to revise the strategies of the agents.

The second step was more participative since it consists in modifying and assessing the model with cattle farmers. In order to make this assessment more lively and efficient, we conceived the xUML tool presented in the Sect. 4.6. From a set of basic operations already available, anyone is able to generate new upper-level behavior without any programming skills.

The use of the xUML editor revealed two interesting features. Firstly, by being able to modify the agents' behavior, anybody could play with the model and therefore better understand its logic. The immediate response obtained after any modification often acts as a stimulus for participants and increases their awareness of its underlying mechanisms. This leads to new questions about how the model operates, but also this has triggered discussions and debates about on how best to address climate crises. In conclusion, although the agent's strategies proposed by the first version of the model had often seemed too simplistic initially, many farmers afterward categorized themselves as traditional producer like the one represented by the model.

The second feature concerns the collective debugging of technical aspects of the model. By testing alternative strategies with the xUML editor, the participants identified some biases: they realized that in drought conditions, the agents always reacted too late. For instance, in case of lack of grass, the decision to feed the herd with supplement did not apparently prevent it from collapsing. The participants understood that the agents had to act more frequently than only once per season as stated by the first version of the model. The consequence was to correct the model by activating the agents every week rather than just once per season.

The results of these collective exercises exceeded our expectations. Beyond discussions and debates they triggered, it has contributed to identify better adaptive strategies so that the resilience of livestock producers can be improved. Furthermore, many of the farmers and technicians who participated in the workshops are continuing the experience with the model. They use it to seek for more effective management strategies under normal and drought periods. Now, we hope it will facilitate the emergence of new and more efficient practices for farm management that can account for climate changes (Bommel et al. 2014).

5.3 Distributed Asymmetric Simulation to Raise Awareness About the Multiple Viewpoints on Interactions Between Biodiversity and Peri-urban Development Projects

In France, urban sprawling is a serious issue in many municipalities as it has major consequences in terms of loss of agricultural and forest area with destruction and fragmentation of habitats for biodiversity. In 2010, the bill dealing with the "Grenelle 2" national commitment for environment has reinforced environmental conservation measures in urban planning at the municipality and inter-municipality scale. Yet at the local level, these measures face difficulties due to the division of tasks and responsibilities related to environmental management in urban planning. Local actors lack an overall view and do not always understand why and how the different stakeholders engage with biodiversity.

To respond to this issue, an ABM was developed that simulates the interactions between land use change and two emblematic species of French countryside: the Montagu's harrier, a red listed migratory bird of prey that plays a role in the regulation of pests and seed dispersal, and the domestic bees, pollinators that provide ecosystem services for sweet chestnut forest. Groundwater quality is also modeled as a direct consequence of the type of land use composing the landscape at a given moment. On the social side, the ABM models the actions of five main stakeholders: a mayor, a property developer, a forester, a farmer, and an ecologist.

Each of them has a specific objective related to the evolution of land use and depends on the others and on ecological dynamics to fulfill it (for more details see Becu et al. 2014). Those stakeholders are actually represented by virtual avatars in the computer simulation and by roles played by human agents who will make the decisions. Thus, the model is actually a hybrid agent simulation model that mixes computerized processes (ecological dynamics, land market demand, popularity of elected representatives, etc.) and human decisions (buy lands, choose agricultural practices and timber harvesting methods, build new constructions, deliver construction permits, promote eco-friendly practices). When running an RPG workshop with the model, the simulation is distributed on several machines, one for each role. On each machine, a specific point of view on the virtual environment is displayed, and a limited number of actions on the virtual entities are available. This customization is done using the habitus functionality of Cormas (Sect. 4.4) and used in distributed mode (Sect. 4.5).

Playing the RPG with such an asymmetric setting helps participants to immerse themselves in the role of those stakeholders and better understand their constraints, their perspective, and why sometime they misunderstand the choices of others about biodiversity conservation (Fig. 13).

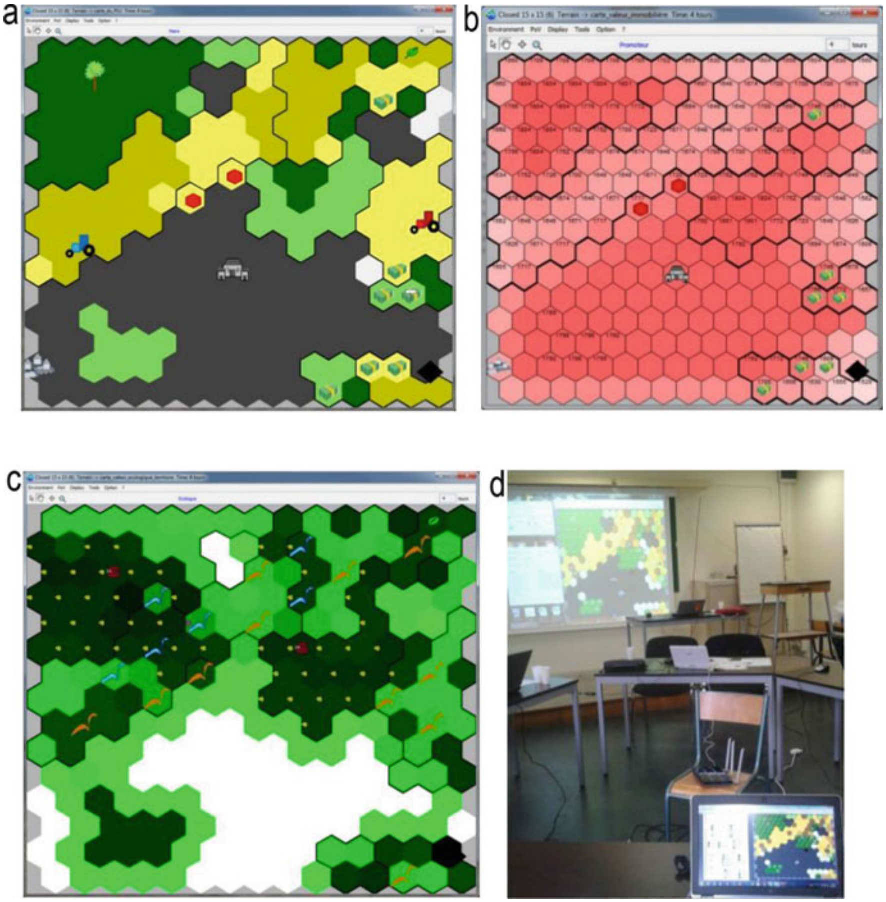

Fig. 13 (**a**) The mayor's habitus displays the map of the local urban development plan that allows the player to act on land transactions that are symbolized by banknotes icons on the map. (**b**) The property developer habitus displays the map of land market prices with which the player interacts with land transaction. (**c**) The ecologist's habitus provides different information and means of action. It displays the location and health of Montagu's harriers and bees, which allows him to survey those populations and measure their ecosystem services. (**d**) The organization of the room

6 Perspectives and Conclusions

Cormas is mainly dedicated for noncomputer scientists, and our objective is to help them in designing, implementing, and assessing reliable and efficient simulation models. For that purpose, we try to keep the platform as simple as possible. This is the reason why Cormas does not propose continuous systems (neither temporally nor spatially). The DEVS – Discrete Event System Specification (Zeigler et al. 2000) – formalism, for instance, is much more sophisticated and enables to simulate realist movements and collisions. But in the domain of resource management, these refinements are not the first priority and seem not essential. More rough concepts often seem sufficient to address the problems of this domain for which the question relies more on an overall understanding of the system rather than on the temporal precision of the interactions.

To help the thematic experts to design and implement their models by reducing their dependency on computer scientists for coding, the future developments of Cormas are focused on the design of user interfaces to automatically generate a part of the computer code. For that, we work on the integration of a class diagram editor that will generate the class structure and their attributes and will translate the associations into code. This tool is expected for the end of 2015.

We also develop a more complete activity diagram editor for manipulating variables. This will allow the modeler to define decision points by graphically describing the test with the model parameters and relational operators. Activities with input and output parameters will be available to define more complex operations than the current editor offers. However, this tool will be useful only for modelers and may not be used with stakeholders.

We are also working on map integration that will enable, for instance, to load maps from Google Earth. A connection with R (a software for statistical computing) is almost ready that enables to run intricate sensitivity analyses from R and display professional statistical graphics.

But the main orientation of Cormas' future remains the interactivity with stakeholders and local actors. That is the reason why the major effort is dedicated on man-machine interfaces and ergonomic design. For instance, we are currently developing an extension for controlling the movement of agents on the spatial grid through tangible objects that are physically moved on a table. This work uses digital recognition of QR code printed on the top of tangible objects. By projecting the spatial grid on a table, this extension will be used in hybrid simulations mixing virtual environments and tangible objects. All these developments are taking place in parallel with concrete field experiences with a variety of local actors in order to deliver meaningful inputs on social and environmental issues.

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References

Barreteau, O. (2003). The joint use of role-playing games and models regarding negotiation processes: Characterization of associations. *Journal of Artificial Societies and Social Simulation, 6*(2). http://jasss.soc.surrey.ac.uk/6/2/3.html.

Barreteau, O., et others. (2003). Our companion modelling approach. *Journal of Artificial Societies and Social Simulation, 6*(1). http://jasss.soc.surrey.ac.uk/6/2/1.html.

Becu, N., Frascaria-Lacoste, N., & Latune, J. (2014). Distributed asymmetric simulation – Enhancing participatory simulation using the concept of habitus., présenté à ISAGA 2014: The shift from teaching to learning: Individual, collective and organizational learning through gaming simulation. Bertelsmann: Dornbirn.

Bommel, P., Dieguez, F., Bartaburu, D., Duarte, E., Montes, E., Pereira Machin, M., Corral, J., de Lucena, C. J. P., & Morales Grosskopf, H. (2014). A further step towards participatory modelling. Fostering stakeholder involvement in designing models by using executable UML. *Journal of Artificial Societies and Social Simulation, 17*(1). http://jasss.soc.surrey.ac.uk/17/1/6.html.

Bourdieu, P. (1980). *Le Sens pratique*. Paris: Éditions de Minuit.

Bousquet, F. (2005). *Companion modeling and multi-agent systems for integrated natural resource management in Asia*. Los Baños: Int. Rice Res. Inst.

Bousquet, F., Barreteau, O., Mullon, C., & Weber, J. (1996). *Modélisation d'accompagnement: systèmes multi-agents et gestion des ressources renouvelables*, présenté à Quel environnement au XXIème siècle ? Environnement, maîtrise du long terme et démocratie, Abbaye de Fontevraud, France.

Bousquet, F., Bakam, I., Proton, H., & Page, C. L. (1998). Cormas: Common-pool resources and multi-agent systems. In A. P. del Pobil, J. Mira, & M. Ali (Eds.), *Tasks and methods in applied artificial intelligence* (pp. 826–837). Berlin: Springer.

Bousquet, F., Barreteau, O., d' Aquino, P., Etienne, M., Boissau, S., Aubert, S., Le Page, C., Babin, D., & Castella, J.-C. (2002). Multi-agent systems and role games: Collective learning processes for ecosystem management. In *Complexity and ecosystem management. The theory and practice of multi-agent systems* (pp. 248–286). Londres: Edward Elgar.

[Collectif ComMod] Bousquet, F., Antona, M., Aubert, S., Barnaud, C., Barreteau, O., Becu, N., Boisseau, S., Bommel, P., Botta, A., Castella, J., et others. (2009). La posture d'accompagnement des processus de prise de décision: les références et les questions transdisciplinaires. In *Modélisation de l'environnement : entre natures et sociétés*., Quae. Hervé Dominique (ed.), Laloë Francis (ed.)., pp. 71–89.

Brauer, J. (2015). The visual works development environment. In *Programming smalltalk – Object-orientation from the beginning* (pp. 77–96). Wiesbaden: Springer Fachmedien.

D'Aquino, P. L. P. (2003). Using self-designed role-playing games and a multi-agent system to empower a local decision-making process for land use management: The SelfCormas experiment in Senegal. *Journal of Artificial Societies and Social Simulation* http://jasss.soc.surrey.ac.uk/6/3/5.html.

Daré, W., & Barreteau, O. (2003). A role-playing game in irrigated system negotiation: Between play and reality., *Journal of Artificial Societies and Social Simulation*, *6*(3). http://jasss.soc.surrey.ac.uk/6/3/6.html.

Deffuant, G., Weisbuch, G., Amblard, F., & Faure, T. (2003). Simple is beautiful? and necessary. *Journal of Artificial Societies and Social Simulation, 6*(1). http://jasss.soc.surrey.ac.uk/6/1/6.html.

Dieguez Cameroni, F. J., Terra, R., Tabarez, S., Bommel, P., Corral, J., Bartaburu, D., Pereira, M., Montes, E., Duarte, E., & Morales Grosskopf, H. (2014). Virtual experiments using a participatory model to explore interactions between climatic variability and management decisions in extensive grazing systems in the basaltic region of Uruguay. *Agricultural Systems, 130*, 89–104.

Etienne, M. (Ed.). (2011). *Companion modelling. A participatory approach to support sustainable development*. Dordrecht: Springer.

Gurung, T. R., Bousquet, F., & Trébuil, G. (2006). Companion modeling, conflict resolution, and institution building: Sharing irrigation water in the Lingmuteychu Watershed, Bhutan. *Ecology and Society, 11*(2), 36.

Janssen, M. A., & Ostrom, E. (2006). Empirically based, agent-based models. *Ecology and Society, 11*(2), 37.

Le Moigne, J.-L. (1995). *Les épistémologies constructivistes*. Paris: Presses Universitaires de France.

Le Page, C., Becu, N., Bommel, P., & Bousquet, F. (2012). Participatory agent-based simulation for renewable resource management: The role of the Cormas simulation platform to nurture a community of practice. *Journal of Artificial Societies & Social Simulation*, *15*(1). http://jasss.soc.surrey.ac.uk/15/1/1.html.

Le Page, C., Bazile, D., Becu, N., Bommel, P., Bousquet, F., Etienne, M., Mathevet, R., Souchère, V., Trébuil, G., & Weber, J. (2013). Agent-based modelling and simulation applied to environmental management. In *Simulating social complexity* (pp. 499–540). Berlin/Heidelberg: Springer.

Le Page, C., Abrami, G., Barreteau, O., Becu, N., Bommel, P., Botta, A., Dray, A., Monteil, C., & Souchère, V. (2014). Models for sharing representations. In *Companion modelling* (pp. 69–101). Dordrecht: Springer.

Le Page, C., Bobo, K. S., Kamgaing, T. O. W., Ngahane, B. F., & Waltert, M. (2015). Interactive simulations with a stylized scale model to codesign with villagers an agent-based model of bushmeat hunting in the periphery of Korup National Park (Cameroon). *Journal of Artificial Societies and Social Simulation, 18*(1), 8.

Mellor, S. J., & Balcer, M. (2002). *Executable UML: A foundation for model-driven architectures*. Boston: Addison-Wesley Longman Publishing Co.

OMG (2005). *The unified modeling language specification v2.0*.

OMG (2008). *Model driven architecture, MDA Guide Version 1.0.1*.

Pepper, J. W., & Smuts, B. B. (2000). The evolution of cooperation in an ecological context: An agent-based model. In T. A. Kohler & G. J. Gumerman (Eds.), *Dynamics of human and primate societies: Agent-based modeling of social and spatial processes* (pp. 45–76). Oxford: Oxford University Press.

Reenskaug, T. (2003). *The model-view-controller (MVC) its past and present*. University of Oslo Draft.

Voinov, A., & Bousquet, F. (2010). Modelling with stakeholders. *Environmental Modelling & Software, 25*(11), 1268–1281.

von Glasersfeld, E. (1999). Le Moigne's defense of constructivism, *GRASCE, Entre systémique et complexité, chemin faisant [Between systemics and complexity – Making the way]* (pp. 85–90). Paris. Available at http://www.vonglasersfeld.com/225.

Wilensky, U., & Reisman, K. (2006). Thinking like a wolf, a sheep, or a firefly: Learning biology through constructing and testing computational theories-an embodied modeling approach. *Cognition and Instruction, 24*(2), 171–209.

Zeigler, B. P., Praehofer, H., & Kim, T. G. (2000). *Theory of modeling and simulation: Integrating discrete event and continuous complex dynamic systems*. San Diego: Academic.

The Fab Safe Game: Preparing Fab Labs and Maker Spaces for Occupational Health and Safety

Pieter van der Hijden and Lipika Bansal

Abstract Fab labs, maker spaces, hacker spaces, repair cafes, etc. are places where the public, school groups, individual tinkerers, and inventors can use computers, machinery, and tools to play, learn, tinker, invent, design, create, and acquire and share knowledge. What stands out in many fab labs, maker spaces, etc. (further called fab labs) is the enthusiasm of people involved. A mix of amateurs and professionals, young and old, and paid staff and volunteers are setting up, running, and using machinery and tools. Their variety in background and interest is a great asset of the lab; the reverse, however, is the absence of a common base of knowledge, practice, and attitudes related to health and safety. Several fab lab managers want to structurally ensure the health and safety of all people involved within their organization. The Fab Safe Game is a tool for them to make this happen. The intended audience of the Fab Safe Game is fab lab management and staff of a specific lab (7–14 people). A game session can be completed in half a day. The participants are divided into three small groups, each playing a different role in the game. The "building manager" is responsible for the lab building and its machines, the "logistics manager" is responsible for activities, materials, and inventory at the lab, and the "lab manager" is responsible for all people, staff, volunteers, and visitors involved at the lab. First, each role develops its own model (view) of the lab, resulting in three views that will be exchanged and cross-checked. Then, they identify safety and health risks and relate them to their own views. Next, they review a card deck with safety conditions and complement their inventory of risks. Finally, they prioritize the list, add desirable measures, and create a global plan to implement them. The paper describes the Fab Safe Game design process.

Keywords Fab lab • Maker movement • Occupational health • Safety • Planning

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1 Introduction

We present the Fab Safe Game problem statement, its purpose, and the requirements it has to fulfill.

1.1 Problem Statement

Fab labs, maker spaces, hacker spaces, repair cafes, etc. are places where the public, school groups, individual tinkerers, and inventors can use computers, machinery, tools, and materials to play, learn, tinker, invent, design, create, and acquire and share knowledge. The concept originated from the Center for Bits and Atoms at MIT around 2001 and found, in many variations, resonance throughout the world (Van der Hijden et al. 2014). Precise figures are not available, but the mere number of registered fab labs grew from 50 in 2010 to almost 500 in early 2015 (Fab Lab World Map 2015).

What stands out in many fab labs, maker spaces, etc. (further called fab labs) is the enthusiasm of all people involved. A mix of amateurs and professionals, young and old, and paid staff and volunteers are setting up, running, and using machinery and tools. Their variety in background and interest is a great asset of the lab; the reverse, however, is the absence of a common base of knowledge, practice, and professional attitudes related to health and safety.

Every country has legislation on occupational health and safety. It mainly cares about the paid workers in labor organizations. Sometimes, internships and volunteers are included and, in the case of educational institutes, pupils and students as well. However, in general, legislation barely covers the safety and health of people who frequent fab labs.

Whether legislation makes it compulsory or not, several fab lab managers simply want to ensure the health and safety of all people involved within their organization. To accomplish this, they have to develop a common vision on safety and health and to identify existing risks, assess them, plan their response, and act accordingly. To support them in this complex task, we developed the Fab Safe Game.

1.2 Purpose of the Game

The purpose of the Fab Safe Game is to offer fab lab management and staff of a specific fab lab a tool to improve the management of health and safety risks in their lab. This includes:

- Raising awareness on health and safety issues
- Developing a shared model of the fab lab

- Building the capacity to cope with health and safety challenges in an efficient and effective way
- Preparing a concrete list of health and safety risks for the specific fab lab, assessed and prioritized
- Preparing an action plan

1.3 Requirements

The requirements the Fab Safe Game has to meet are:

- The intended audience of the game is the management and staff of a local lab. Since their time might be limited, the game session should preferably run in a single half day.
- The game should be useful for fab labs worldwide. It should be applicable internationally, i.e., not bound to any specific legislation. At the same time, the game should result in an action plan which is concrete and specific for the fab lab.
- The game should be inclusive, i.e., taking into account all the people in the lab and/or its direct environment (visitors, pupils/students, volunteers, and staff).
- The game should be easy to set up and run: little preparation time, runnable with in-house expertise, and little time required for documentation afterward.
- The game kit should be easy to reproduce.

2 Problem Analysis

We present a conceptual framework on occupational health and safety for fab labs and how the Fab Safe Game can support lab managers, in co-creation with others, to develop a concrete action plan.

2.1 Conceptual Framework

A commonly used approach to risks is described, which reflects on rules and regulations and refers to existing support tools.

2.1.1 Risk Management

A responsible manager needs to be aware of risks involved within their lab. In our case the emphasis lies on health and safety risks within a fab lab. By providing game participants the tools, they prioritize risks, focusing their time and effort on the most important risks (Dumbrava et al. 2013).

Within a fab lab, various hazardous occurrences could take place impacting the health and safety of people. Usually probability and impact are distinguished. The product of both factors determines the risk level. Depending on the risk level, an organization can formulate its strategy. A risk can simply be accepted, it can be shared with other parties (insurance), and it can be transferred to other parties (making it another party's responsibility). Moreover its impact can be reduced to an incidental or structural risk or the risk itself may be mitigated or even avoided. The whole can be assessed at operational, tactical, and strategical levels and consists of people, responsibilities, permissions, and systems (Office of Government Commerce 2009).

2.1.2 Rules and Regulations

Every country has legislation on occupational health and safety. What do countries have in common, what are typical differences? A thorough study is out of scope for this game design effort. As an example, an earlier study comparing occupational health and safety in Japan and the Netherlands by Jan Siemons has been used (1992).

Siemons found that cultural factors, political-administrative factors, socioeconomic factors, technological factors, and differences in the industrial relations system and work environment influence the implementation of occupational safety and health policies in both countries. Japan and the Netherlands differ in almost all factors.

What both countries have in common, however, is their basic attitude toward risks. Government regulations accept the existence of organizational health and safety risks. They require organizations to assess the risks, to evaluate their impact, and to prepare a plan to cope with them. The risk assessment and evaluation should meet certain criteria and the plan should naturally be implemented.

2.1.3 Existing Tools

Encouraging companies to take responsibility for safety and health is one thing; however, to get companies to take action is something different. According to a study by the Dutch government, especially small and medium enterprises (SMEs) lack in-house expertise and often do not have the financial means to hire external consultants to complete paperwork and follow up on safety and health activities. Therefore, the government supports the advent of various online tools and has contributed by setting up a web portal in order to access these tools (Steunpunt RIE 2015).

The website of the Support Center for Risk Inventory and Evaluation (RIE) in the Netherlands contains instruments for risk analysis for dozens of industries.

These instruments refer to 150+ so-called working conditions catalogues (arbocatalogus) with practical solutions. At the European level, various countries including the Netherlands contribute by providing such tools to OiRA (Online Interactive Risk Assessment – OiRA 2015), an initiative of the European Agency for Safety and Health at Work (2015).

2.1.4 Fab Labs

As fab labs are not considered as an industry on their own, we have analyzed the collection of industry-specific tools relevant for fab labs.

We consider a fab lab as:

- A small enterprise
- Frequented by *special categories of people*: pupils/students as in schools, volunteers, people with handicaps as in sheltered workshops, and the general public as found in libraries, art education and participation, and the leisure industry
- Working with *special materials*, mainly wood, metal, rubber, and plastics
- Involved in *special processes*, like design and ICT, crafts, copy and sign shops

We have made a selection from the dozens of sector-specific tools. These sector tools correspond with our definition of a fab lab: small enterprises, frequented by special categories of people, involving special materials and processes. This has resulted in approximately 20 tools for review.

We found that about half of the tools for review are not available for free. Either they have a price or are part of a package deal with consultants or they are only available for (paying) members of particular sector organizations (Fig. 1).

By reviewing the other half, we learned:

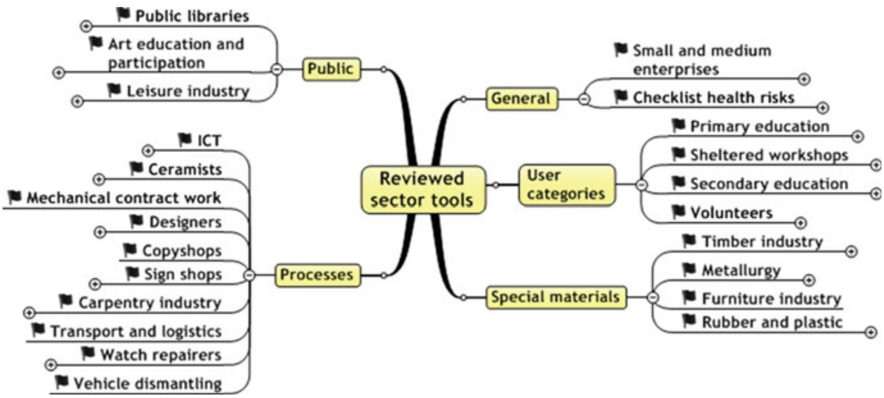


Fig. 1 Reviewed sector tools

- The tool for SMEs is a practical useful guide: It is a generic tool which covers a variety of industries; hence, it can be extended to safety and health management in fab labs as well.
- The “Checklist Health Risks (bron)” overlaps with the generic tool for SMEs.
- The other tools have similar content as the generic tool augmented with sector-specific content which is relatively limited in size. It is recommended for further reading (RI&E-Instrumenten 2015):
  - *Primary schools*: hygiene, child-friendly building, and surroundings
  - *Secondary schools*: various specialized labs, workshops, studios
  - *Sheltered workshops*: people with handicaps in language, in reading, in using personal protection tools
  - *Volunteers*: safety during (outreach) events
  - *Public libraries*: operating from library bus and at events elsewhere
- *Art education and participation*: counters, machine/installation safety

2.2 Game Design

As the game has to be rather generic, while the outcomes should be rather specific, the game lets participants build their own (shared) model for their specific lab.

The game simulates the general processes of risk management as should be conducted by management and staff: identifying risks, assessing them, and planning and implementing actions. Since raising awareness is important, the game firstly lets participants construct their own knowledge and identify risks related to their own lab. Next, the participants’ identified risks are assessed and analyzed by comparing them with existing risk categories, which are prioritized per risk. Finally, participants produce an action plan and implement it within a particular time frame. The game design is based on the existing risk inventory tool for SMEs; it contains 10 categories with 164 potential risks (Fig. 2).

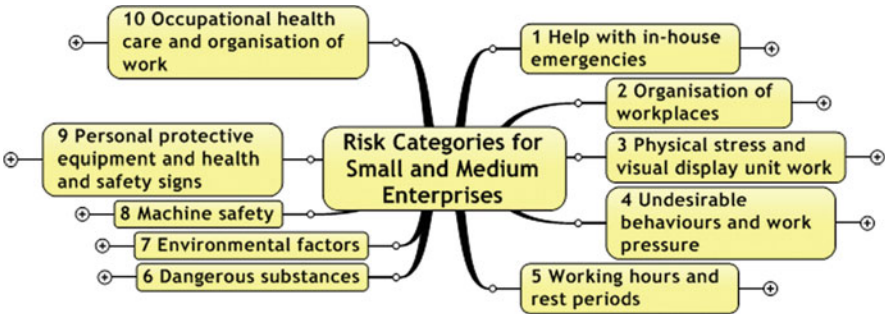


Fig. 2 Risk categories for small and medium enterprises

3 Game Structure

We describe the structure of the game in terms of roles, initial state, game room, and game board.

3.1 Roles

The aim is to create a shared awareness of the actual state of the lab, a common risk assessment, and commitment to its implementation plan. Therefore, instead of simulating regular fab lab operations by the management, staff, and visitors, the game simulates the risk management process to be played by a group of people committed to health and safety in the lab. To make this process with its many variables manageable, three different aspects or views have been distinguished, and consequently three symbolic roles have been identified for the game play. In order to get participants to think from a particular perspective, three symbolic roles have been chosen, each describing and representing the responsibilities, tasks, and activities related to a specific view (spatial, temporal, and people). The three symbolic roles are "building manager," "logistics manager," and "lab manager" (Table 1).

Table 1 Three roles, three views

Role	View	Description	Risk category
Building manager	Spatial, static view	The layout of the building and the position of installations and machines; technical infrastructure	2. Organization of workplaces
			7. Environmental factors
Logistics manager	Temporal, dynamic view	The schedule of activities, services, logistics, inventory	6. Dangerous substances
			8. Machine safety
Lab manager	People view	Profiles of visitors and staff, volunteers	3. Physical stress and visual display unit work
			4. Undesirable behaviors and work pressure
			5. Working hours and rest periods
			9. Personal protective equipment and health and safety signs
Building manager, logistics manager, lab manager	All views	All roles, activities, processes	1. Help with in-house emergencies
			10. Occupational health care and organization of work

3.2 Initial State

Usually a game starts off with an initial state. The Fab Safe Game commences with the initial state of the fab lab at hand, e.g., a case description, assuming that the participants (the managers and staff members of a specific lab) have this prior, practical, and tacit knowledge at hand.

In case participants from various labs decide to come together to play the game, a case description of an arbitrary fab lab will be provided. This is in order to give the players a common background to start the game.

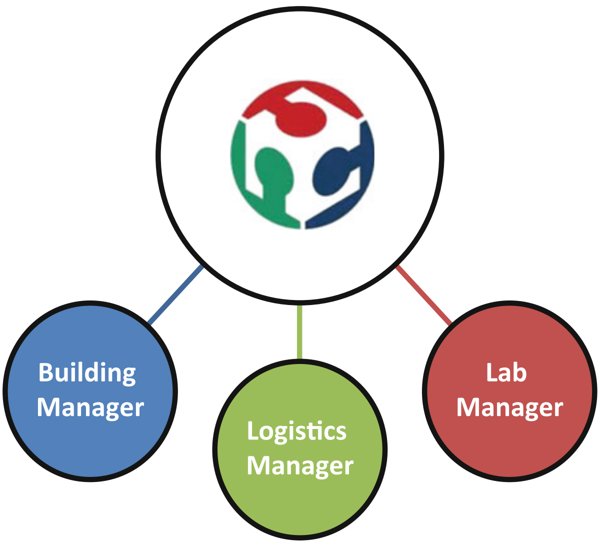
3.3 Game Room

The game room has three workspaces for the three distinguished roles (small groups) and a common workspace for plenary interactions (Fig. 3).

3.4 Game Board

The aim of this game board is to support fab lab managers and staff (1) to focus on the cause, (2) visualize the fab lab model, (3) facilitate cross-checking, and (4) document results in order to prioritize health and safety risks and develop an action plan.

Fig. 3 Layout of the game room



The Fab Safe Game lets participants take command, from their respective role, to develop three views, resulting in a fourth view:

1. Spatial view: a layout of the building
2. Temporal view: the weekly schedule of activities
3. People view: profiles of visitors and staff
4. Risk management view: identify, assess, plan, and act

The four views are combined in a game board (A0 size) consisting of four quarters, i.e., the four views.

The participants are open to represent their respective view the way they think is appropriate for their specific context.

To conclude:

- Each role is provided with graph paper (A3 size), colored stickers, and markers for preparing their view. It is up to the players how to use the tools. See examples below.
- Each role is also provided with stickers and a workspace to prepare a list of risks (see below).
- On the central table, or on a wall nearby, a canvas is provided for the plenary sessions and central outcomes of the game: a prioritized list of risks, effects, actions, and planning details (Figs. 4, 5, 6, 7, and 8).

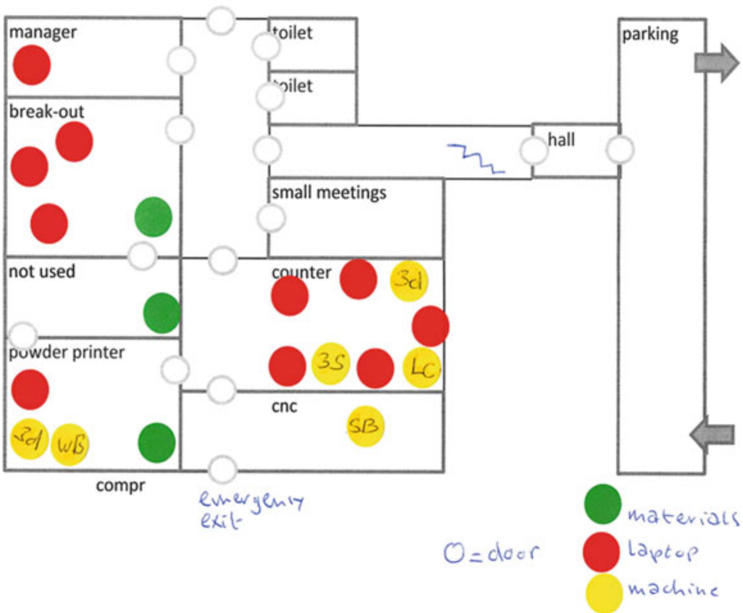


Fig. 4 Example of spatial view

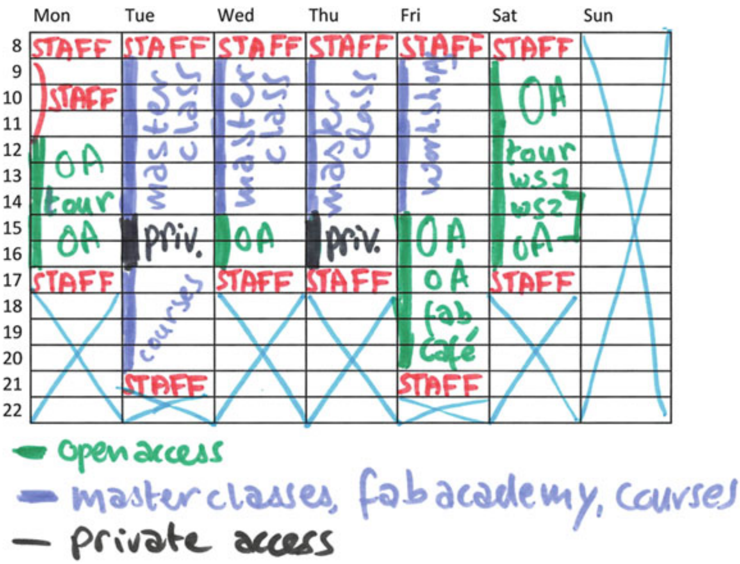


Fig. 5 Example of temporal view

Fig. 6 People view

Identify				Assess		Plan		
Priority	Risk	Impact	Location Activity People	Risk level	Strategy	What?	Who?	When?
1								
2								
3								

Fig. 7 Risk view canvas

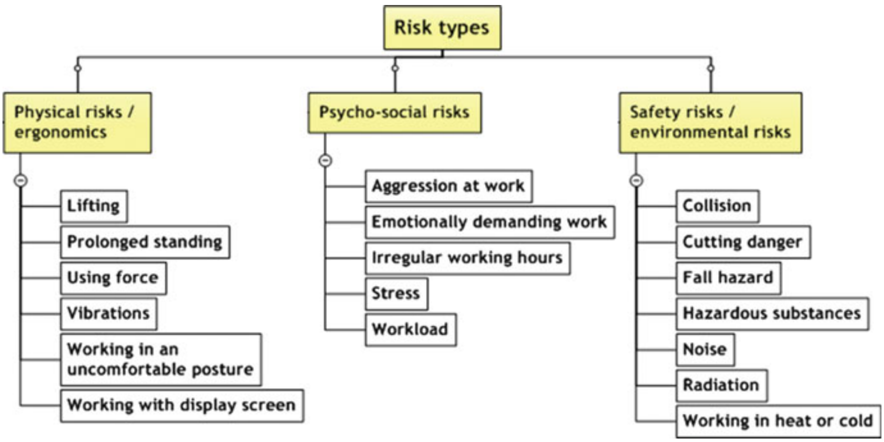


Fig. 8 Common risks summary

4 Game Process

The game process is described in terms of a macro-cycle with embedded micro-cycles (Duke 1974). For the whole game session, the macro-cycle, 4 h are required. Within the macro-cycle, four micro-cycles of 45 min are embedded, separated two by two by a short break of 15 min.

The game macro-cycle consists of:

- 15′ – Welcome
- 15′ – Briefing
- 195′ – Micro-cycles
  - 45′: Cycle 1 – Mapping the lab
  - 45′: Cycle 2 – Identifying risks
  - 15′: Short break

  - 45′: Cycle 3 – Assessing risks
  - 45’: Cycle 4 – Planning and implementing
- 15′ – Debriefing

4.1 15’: Welcome

15″ – Plenary	Participants and facilitators introduce each other and inform how they relate to the fab lab and the theme “Safety and Health at Work”

4.2 15′: Briefing

15″ – Plenary	The facilitator gives a brief and motivating presentation on the topic and explains the rules of the Fab Safe Game. There is a quick check, whether the expectations of the participants and the game’s goals match
	Finally, the facilitator allocates the participants to their respective roles (building manager, logistics manager, and lab manager)

4.3 45′: Cycle 1– Setting the Stage

Input	Case description (in case participants come from various labs)
30′ – Group work	Each role develops a view of their respective situation (see 3.1. Roles section for details)
15′ – Plenary	The building managers organize a plenary meeting, chair it, and document the outcomes
	The roles exchange their views, cross-check them, and update them where required
Output	Three views

4.4 45′: Cycle 2 – Identifying Risks

Input	Each role uses its own view plus a “common risks summary” sheet (see figure)
30′ – Group work	During this brainstorming session, each role identifies risks related to their view. Participants may use the common risks summary for inspiration. Ultimately they have to reduce their number of risks to maximum seven

(continued)

15′ – Plenary	The logistics managers organize a plenary meeting, chair it, and document the outcomes
	Roles discuss their lists of maximum seven risks. In case of overlapping risks, one role becomes the owner
Output	Each role has its own list of maximum seven risks related to their view

4.5 15′: Short Break

4.5.1 45′: Cycle 3 – Assessing Risks

Input	Each role has:
	Its own view
	List of maximum seven identified risks
	Cards for selected risk categories (see section "Roles" for details)
30′ – Group work	Each role goes through its card deck and identifies relevant risks
	They merge them with the risks they identified before
	They ultimately select the seven risks with the highest priority
15′ – Plenary	The lab managers organize a plenary meeting, chair it, and document the outcomes
	The roles shortly present their updated list of seven risks. Transfers are possible
Output	Each role has maximum seven reviewed and prioritized risks

4.6 45′: Cycle 4 – Planning and Implementing

Input	Each role has:
	Maximum seven reviewed and prioritized risks
	New part of card deck (all roles are the same)
15′ – Group work (shorter than earlier rounds!)	Each role checks the new cards and identifies the most relevant risks
30′ – Plenary (longer than earlier rounds!)	Building managers organize a plenary meeting, chair it, and document the outcomes
	The roles compare their assessment of the last cards and combine their outcomes to additional seven cards
	Now each role has a maximum of seven cards + an additional seven common cards, bringing it to a total of 28 cards
	Participants discuss how to reduce the total number of cards to seven most important/urgent risks
	These seven cards are stuck to the plan board
	The remaining columns of the risk view are completed
Output	Risk view plan board with seven risks (implementation plan)

4.7 15′: Debriefing

15″’ – Plenary	Debriefing of the game session consists of:
	A short round on the participants’ experience of the game
	What they learned
	Commitments they want to share and take up
	Suggestions to improve the game

5 Conclusion

The Fab Safe Game offers participants a 4 h experience focusing on a range of safety and health issues, related to their specific fab lab. The spatial, temporal, and people views of the lab form a shared model of the actual fab lab and the dynamics of its daily operations. The game lets participants practice a method to develop their risk management in an accessible manner, which can be applied independently in the future, and therefore is sustainable. Moreover, the game session results in a concrete implementation plan to cope with prioritized health and safety issues.

In order to acquire an effective outcome of the Fab Safe Game, the game should preferably be played by a variety of people, representing the three symbolic roles, and having relevant local knowledge. Furthermore the number of participants should not be lower than six (two per role). Given the number of activities, a 4 h game play is indispensable. A shorter session is not advised; on the contrary, it would be better to play the game in double time in order to make well-informed decisions. Via test runs we hope to find whether management and staff of fab labs are prepared to spend this time to(ward) health and safety.

The game is easy to set up. In fact the facilitator only has to set up the room and supply consumables such as regular office supplies. Reproducing the game kit is a matter of running a print job.

At the time of writing, the game is ready for test runs.

References

Duke, R. (1974). *Gaming, the future’s language*. New York: Sage Publications.

Dumbravă, V., Iacob, V. S. (2013). Using probability–impact matrix in analysis and risk assessment projects. Descrierea CIP/Description of CIP–Biblioteca Națională a României Conferința Internațională Educație și Creativitate pentru o Societate Bazată pe Cunoaștere–ŞTIINŢE ECONOMICE, 42.

European Agency for Safety and Health at Work. (2015). Retrieved May 1, 2015, from https://osha.europa.eu/en?set_language=en

Fab Lab World Map. (2015). *Fab Lab World Map*. Retrieved June 9, 2015, from https://www.fablabs.io/map

Office of Government Commerce. (2009). *Managing successful projects with PRINCE2* (2009th ed.). Norwich: The Stationary Office.

Online Interactive Risk Assessment – OiRA. (2015). Retrieved May 12, 2015, from http://www.oiraproject.eu/

RI&E-Instrumenten. (2015). Retrieved June 23, 2015, from http://www.rie.nl/rie-instrumenten/

Siemons, J. (1992). *Occupational safety and health policy implementation: A comparison between Japan and The Netherlands*. PhD thesis. Enschede: University of Twente.

Steunpunt RIE. (2015). Retrieved May 1, 2015, from http://www.rie.nl/

Van der Hijden, P., & Juarez, B., et al. (2014). *The Fab Lab Life cycle*. Report of the FAB10 workshops; workshops held at FAB10 International Fab Lab Conference, Barcelona, Spain, July 2014. Retrieved from http://slidesha.re/1wzP2mJ

Knowledge Brokers in Action: A Game-Based Approach for Strengthening Evidence-Based Policies

Karol Olejniczak, Tomasz Kupiec, and Igor Widawski

Abstract Public policies need research results in order to effectively address the complex socioeconomic challenges (so-called evidence-based policies). However there is a clear gap between producing scientific expertise and using it in public decision-making. This "know-do" gap is common in all policy areas. Knowledge brokering is a new and promising practice for tackling the challenge of evidence use. It means that selected civil servants play the role of intermediaries who steer the flow of knowledge between its producers (experts and researchers) and users (decision-makers and public managers). Knowledge brokering requires a specific combination of skills that can be learned effectively only by experience. However this is very challenging in the public sector. Experiential learning requires learning from own actions – often own mistakes, while public institutions tend to avoid risk and are naturally concerned with the costs of potential errors. Therefore, a special approach is required to teach civil servants.

This chapter addresses the question of how to develop knowledge brokering skills for civil servants working in analytical units. It reports on the application of a simulation game to teach civil servants through experiential learning in a risk-free environment. The chapter (1) introduces the concept of knowledge brokering, (2) shows how it was translated into a game design and applied in the teaching process of civil servants, and (3) reflects on further improvement. It concludes that serious game simulation is a promising tool for teaching knowledge brokering to public policy practitioners.

Keywords Knowledge broker • Knowledge use • Public management • Teaching civil servants • Serious games

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1 Introduction

1.1 The Challenge of Knowledge Brokering

Decision-makers and public managers need research results in order to conduct effective public interventions that serve citizens and improve socioeconomic development. The usefulness of evidence-based policies is confirmed by both modern literature on public policies and the practice of public management (Banks 2009; Cartwright and Hardie 2012; Nutley et al. 2007; Shillabeer et al. 2011).

However, there is a clear gap between producing research studies (including applied expertise such as evaluations) and using their results in decision-making (Cartwright 2013; Majone 1992; Shulha and Cousins 1997; Weiss and Bucuvalas 1980).

Recent literature on evidence use in public policies points to "knowledge brokering" as a promising strategy for tackling the "know-do" gap (Dobbins et al. 2009; Lomas 2007; Waqa et al. 2013; Clark and Kelly 2005; Oliver et al. 2014). Knowledge brokering requires a set of specific skills: (1) recognizing the knowledge needs of policy actors, (2) acquiring credible studies, (3) reaching users with appropriate dissemination strategies, and (4) combining the results of different studies into an evidence-based foundation for decisions.

Government agencies try to build the knowledge brokering skills of their personnel. However, this is very challenging in the public sector. First, knowledge brokers in the public sector operate on the brink of two rationalities, where the rational, evidence-based approach collides with the logic of political negotiations (Bots et al. 2010; Sanderson 2002). Second, effective learning requires experimentation and learning from one's own actions, often own mistakes, while public institutions tend to avoid risk and are naturally concerned with costs of potential errors (Barrados and Mayne 2003; Hood 2007). Therefore, a special approach is required to teach these skills.

1.2 Chapter Aim and Contribution to the Current Practice of Teaching with Games

This chapter addresses the problem of teaching civil servants knowledge brokering skills, with the use of experiential learning in a risk-free environment. The chapter reports on the application of a specially designed simulation tabletop game for teaching Polish civil servants (for more information on the game, see http://www.knowledgebrokers.edu.pl). It is an example of gaming research in policy area that uses serious games for policy implementation and organizational change (compare Caluwe et al. 2012).

The chapter brings the following new contributions to current practice and literature: In terms of the topic, the chapter introduces serious gaming as a new tool for addressing an important public policy issue – effective research utilization in decision-making. In terms of players, the chapter illustrates how the game was used to teach a very conservative and demanding type of learners – public civil servants. In terms of application, the chapter shows how the game can effectively address the challenge of experiential teaching in an organizational environment that has low tolerance of risk and experimentation.

The chapter has practical value for two groups of audiences. For professionals who teach evaluation and for public sector officials, it shows an innovative way of approaching training. For experts in gaming and simulation, it offers an illustration of how the complex reality of public program delivery can be turned into a game design without losing its connection with reality.

1.3 Method

The reported game application is grounded in sound, scientific evidence. The content of the game is based on (1) 7 years of the Academy of Evaluation postgraduate program for Polish senior civil servants, (2) a systematic review of literature on evaluation use and knowledge brokering (over 900 research chapters), and (3) empirical research of evaluation unit practices (a survey of Polish units, interviews, consultations, and focus groups with representatives of European and American evaluation units) (Olejniczak et al. 2016).

The initial workshop and game design was developed during the ISAGA 2014 summer school. The game mechanics were tested during two game sessions with ten representatives of Polish evaluation units. After each session both the content and form of the game were modified. Further calibration of the workshop content was performed during a session with MA students of regional development studies.

The chapter is divided into three sections. In the next section, the theoretical framework of the simulation is discussed. The second section explains how the theory was translated into a game design and applied in the teaching process of civil servants. The final section presents an initial evaluation of the game's effectiveness and reflection on further improvements.

2 Theoretical Framework

The content of the game focuses on the practice of knowledge brokering. It has been grounded in extensive literature and empirical research on evidence use in decision-making and knowledge brokering.

Knowledge brokers (KBs) are units in government that serve as an intermediary between the worlds of science, politics, and public interest (Gutierrez 2010; Fischer 2003). These are always persons or a group of people, not an automated system or a database (McAneney et al. 2010).

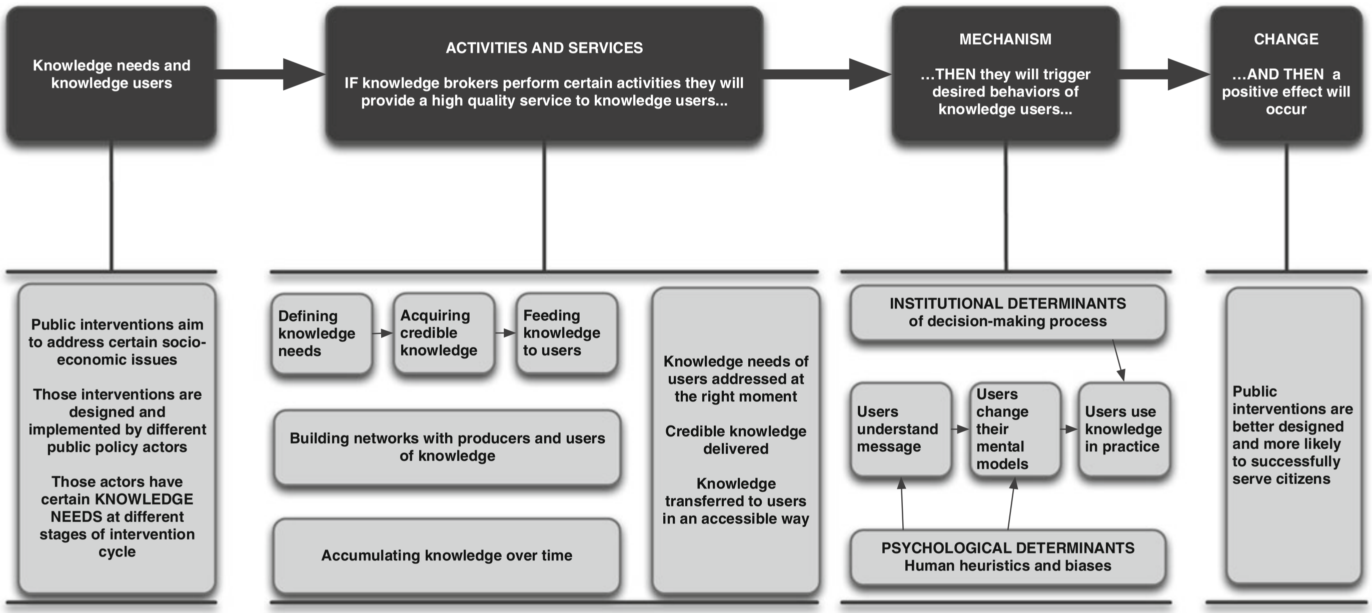

Fig. 1 The logic of knowledge brokering (Olejniczak et al. 2016)

The goal of knowledge brokers is to help decision-makers in acquiring and using credible knowledge for better planning and implementing of public interventions. Thus, successful knowledge brokering leads to effective public intervention and social betterment (Olejniczak et al. 2016).

Figure 1 presents the logic of knowledge brokering activities as a factor that improves the effectiveness of public interventions. The core narrative of this logic is as follows: actors involved in running public policies have certain knowledge needs at different stages of policy interventions. If the knowledge broker executes a set of actions that provide those policy actors with useful knowledge, then the actors, by absorbing that knowledge, will deepen their understanding of public intervention, and then they will plan and implement intervention in a way that better serves the public interest. As we can see, the job of knowledge brokers is mainly about recognizing the knowledge needs of decision-makers, finding and combining evidence and experiences from different sources, translating them into the language of practice, and introducing them to the world of practitioners (Lin 2012; Mavoa et al. 2012; Willems et al. 2013).

There are four points that are crucial for the way knowledge brokers operate. First, the focal point is public intervention or, to be more specific, knowledge needs concerning a particular intervention and the problems and issues arising from it. This means that brokers have to follow the policy implementation cycle.

Second, knowledge needs are always articulated by a particular actor – politicians, senior civil servants, or managers. So, there is a clearly defined group of knowledge users, in other words – clients of the brokers.

Third, success in brokering depends on the configuration of factors. The broker has to match different elements with each other: (a) the type of knowledge needed with the method of acquiring it (research design), (b) client types with knowledge feeding methods, and (c) timing of knowledge delivery.

Fourth, there is a certain degree of uncertainty between the brokers' action and their impact on a decision. Research evidence is only one of many factors influencing the decision-making process. Other factors are political rationality, organizational dynamics, characteristics, and reasoning processes of the knowledge users. However the better the quality of brokers' activities and the stronger the evidence base they present, the higher the chances of positive influence.

3 Practical Application

3.1 Game Description

The overall aim of the game was to teach participants the key skills of knowledge brokering required for playing the role of an intermediary who steers the flow of knowledge between its producers and users. These skills are (1) understanding knowledge needs, (2) acquiring credible knowledge, (3) feeding knowledge effectively to users, (4) building an evidence-based foundation for public interventions, and (5) managing an analytical unit.

The initial idea of the game was to allow civil servants see the simplified mechanisms of decision-making and reflect on them while at the same time keeping it concrete, not too abstract or out of their comfort zone. Therefore, the decision was not to use a metaphor but, instead, to recreate in a game the key operational rules and elements of the system that are familiar to civil servants. The challenge was to transfer the key elements of the system into a game while at the same time reducing the complexity of the real-life operations of regional policies. Eventually, the following narrative was developed.

Participants are divided into six groups. Each group manages an analytical unit in a region. Their mission is to support decision-makers with expertise in implementing four types of socioeconomic interventions. These are combating single mothers' unemployment, developing a healthcare network, revitalizing a downtown area, and developing a public transportation system for a metropolitan area.

With each turn in the game, knowledge needs appear for each intervention. They can relate to a descriptive or diagnostic issue of the problem tackled by the intervention (know about the issue), explore the effects of the implemented or planned solutions (know what works), inquire about the explanation for the success or failures of the particular project (know why things work), or refer to procedural, managerial issues (know how to implement).

Knowledge needs take the form of concrete questions that relate to issues arising during different implementation stages of these projects. For example, in a project on the public transportation system, during its implementation phase, the following questions arise: (a) How do habitants of the metropolis use the new network of transport connections (including the different transportation modes available) provided by the public authorities? (b) What barriers do disabled persons experience when using the newly introduced public transportation system? (c) How to change prices for public transport tickets and charges for parking in the downtown area to encourage citizens to switch from driving their private vehicles to using public transportation?

Over the course of the game, players have to react to 19 different knowledge needs, often appearing simultaneously in different public interventions. Players have to (1) contract out studies with an appropriate research design, (2) choose key users of the study, and (3) choose methods for feeding knowledge to users. The spectrum of options available to players is presented in Table 1.

The choices of players are determined by the resources available to them: the number of staff in their units and the time required to complete each task. Players can be proactive and invest their resources in networking (to discover knowledge needs in advance) or archive searching (to find already existing studies). Players delegate staff members to these tasks. While networking or archive searching, it is impossible for that particular staff member to engage in any other activity during the current round (e.g., report preparation).

After each turn, each group receives detailed feedback that includes three elements: (1) a percentage on how well the team matched research designs to knowledge needs and feeding methods to users, and the higher the match, the

Table 1 Options available to players

Item	Description	Available options
Research designs	Research designs are logical structures that guide the execution of research methods and the analysis of data	(1) Meta-analysis
		(2) Experiments and quasi-experiments
	Different research designs are appropriate for different research questions	(3) Statistical study
		(4) Simulation game
		(5) Theory-driven evaluation
		(6) Case study
		(7) Participatory approach
		(8) Descriptive study
Knowledge users	Types of decision-makers who can use research results for the design and management of public interventions. Each type is interested in different knowledge and has certain preferences for knowledge feeding methods	(1) Politician
		(2) Head of a department
		(3) Project manager
Knowledge feeding methods	Forms of presenting research results and channels of disseminating those results to knowledge users	Forms of presentation
		1. Policy brief
		2. Recommendation table
		3. Logic model
		4. Video presentation or iconographic
		5. Argument map
		6. Dashboard
		Channels of dissemination
		7. Small discussion meeting
		8. Big meeting or conference
		9. Contact through advisors
		10. Personal contact with user

higher are the chances that knowledge will be used by decision-makers; (2) information on the final effect: if a policy actor made a decision based on delivered knowledge or other premises (e.g., political rationale), and (3) hints on good research designs, types of users, and feeding methods for future turns.

Groups of players compete with each other. Depending on how well they match research designs, users, and feeding methods, they receive up to 100 points per knowledge need. Teams accumulate points throughout the game and the winning team is the one with the highest score. However, there is also another way to assess

Table 2 Knowledge brokers' skills translated into game learning goals

Key skills of knowledge broker	What it means for players
(1) Understanding knowledge needs	(1a) Players recognize different stages of an intervention
	(1b) Players recognize involvement of different actors at different intervention stages
	(1c) Players recognize different types of knowledge needs and the form of questions in which they are articulated
(2) Acquiring credible knowledge	(2a) Players match research questions with optimal research designs
	(2b) Players match research questions to types of interventions
(3) Feeding knowledge effectively to users	(3a) Players match feeding methods to the types of users
	(3b) Players recognize and combine two different types of feeding methods – those related to communication forms and those related to channels of dissemination
(4) Building evidence-based foundations for public interventions	(4a) Players combine results of different studies to build a coherent argument – a knowledge stream
	(4b) Players understand that evidence is only a part of decision-making; other considerations (e.g., politics) can heavily influence the result of their mission
(5) Managing an analytical unit	(5a) Players understand the whole sequence of KB unit activities
	(5b) Players manage the time and staff of their unit
	(5c) Players know that a proactive approach pays off – looking for knowledge needs in advance gives more time for strategy development

players' performance. Each result for an individual knowledge need (ranging from 0 to 100) is a probability rate that determines what is the chance that the report will be actually used by the decision-maker. The algorithm checks, based on this probability, if a particular report will be used by a decision-maker and then notes it in a different section of the team score. In effect, every team has two types of score: the first based on accumulation of points throughout the game and the second that informs players how many reports were actually used. The second type of scoring involves a strong element of randomness and luck (a team might succeed even if a report was worth only 20 points – which gives it a 0.2 chance of being used), while the first one reflects how well players can prepare reports. That is why facilitators put more emphasis on the first type of scoring, but at the same time, they also remind participants that there is always an element of luck and randomness in decision-maker use of reports for policy processes.

The learning goals of the workshop were grounded in research literature on knowledge brokering (compare previous section). They were translated into the list presented in Table 2.

3.2 Game's Structure and Mechanics

The simulation is structured as a progression game. It relies on a tightly controlled sequence of events that offers many predesigned challenges (Adams and Dormans 2012). Each team follows the same scenario, operating within a predefined timeline and with access to a certain number of given resources (Table 3).

The progression structure was chosen for three reasons. The first reason was related to one of the learning goals (goal 5a). It was to introduce players to the full process of knowledge brokering within analytical units. This is a well-defined process (both in literature and in practice) and it is based on certain intermediary phases and steps. The progression structure of the game allowed designers to recreate the chronology of this process, so that the players can understand the logic behind the procedures that they will encounter in real-life situations.

The second reason was an approach to facilitation. Due to the complex nature of the knowledge brokering process itself, it was important to grant the facilitator tools for easy control over the game play. The tightly controlled sequence of events and predefined progression of the game are helpful for having an overview of the current situation and enhance the ability of the facilitator to identify challenges and problems that players might face at a particular moment. This knowledge is crucial in terms of ongoing observation, assistance, and providing feedback.

The third reason for the progression game structure was flow and learning. In order to design an engaging learning process, it is necessary to adjust the level of challenges to the skills of participants and keep the right balance between the two as the game progresses (Pavlas 2010). Control over the exact order of incoming "knowledge needs" and events is necessary in a game like KB to keep players in a state of flow instead of anxiety or boredom. Even a minor disruption or the wrong combination of resources, events, and time given for a round might strongly influence the stability of the learning process.

The game of knowledge brokering uses five types of mechanics. These are achievements, countdown, resource management, collaboration, and unexpected events. We briefly discuss them below:

1. Achievements

   The psychological drive of achievement is well known and often used in both offline and online games (Felicia 2011). A system of achievements motivates players to perform a certain number of specific actions and provides automatic feedback. In most cases, it is accompanied by some sort of progression mechanic (e.g., progression bar), which helps players to notice how many actions of a certain type should be performed to gain an achievement. In the KB game, there are 19 achievements. These are 19 knowledge needs that need to be understood and resolved by the player in a certain amount of time. Players are presented with up to six steps to complete the report and deliver it to the decision-maker. These steps may be considered as a form of a progression bar that a player needs to complete to gain an achievement. The player can decide whether to have a three-, five-, or even six-step progress bar. Every additional step increases the

Table 3 Sequence of the round

Step of the round	Description
1. Timeline update	Each team moves the time marker to indicate the current round. Every round is 1 month
2. Resource recovery	Each team collects all the resources taken from them in the previous round. Recovered resources include networker, archivist, components of a finished report, staff members, research designs, knowledge users, and knowledge feeding methods
3. Event	In each round there is an event that influences the current state of the evaluation unit. Some of the events are helpful to the player (e.g., recruitment of new staff members) and some are harmful (e.g., delays in report preparation, blocked resources, etc.). A number of events are formulated as an alternative: players can do A or B. Each team is obliged to make a choice between these two options and faces the consequences of the chosen strategy. The order of events is strictly planned and every group playing the game will encounter the same challenges
4. Delivery of finished reports	Every finished report should be delivered with all the resources placed on it to the facilitator. All the data from the report is then transferred into the system and the score for the team is counted
5. Distribution of new knowledge needs	Each team receives a predefined number of new knowledge needs designed for a current round. If a team has already collected knowledge needs in advance (thanks to a networker), it does not receive a knowledge need designed for the next round. For example, in round 2, players receive four new knowledge needs (one for each intervention); in round 2 they send a networker to collect knowledge needs in advance for intervention A. Then at the beginning of the round 3 during the phase "distribution of new knowledge needs," they receive knowledge needs for interventions B, C, and D, but not A (they already have it)
6. Action	Each team begins their work on new reports and can send a networker or archivist

probability that the completed report will be used by a policy actor – and so increases the quality of a gained achievement. After delivering a completed report, players receive a feedback form that informs them about the efficiency and the result of their work.

2. Countdown

   In many games a countdown mechanism is used to add more frenetic activity (Penenberg 2013). It forces players to accelerate their decision-making process and engages them on an emotional level. There are two ways in which a countdown mechanic is used in the KB game. First, the main element of the board is a calendar that sets deadlines for particular tasks. It is an axis of players' activity that demands their attention and frames their experience. With every round a special pawn is moved to indicate that the time is passing and there is not much left to prepare new reports. Players need to constantly keep an eye on the calendar and adapt to the current situation. The second countdown mechanism is the set time limit for a round (from 7 to 20 min). This mechanism is still being calibrated to the exact amount of time to create a "countdown effect" and generate engagement.

3. Resource management
   The main resources in the game are the pawns that represent the staff of the evaluation unit. Players can send a staff member to perform one of the listed actions: (a) prepare report for a specific knowledge need, (b) provide additional feeding methods to a report, (c) browse and collect materials from archives/databases, (d) network with decision-makers and acquire knowledge needs in advance, and (e) solve unexpected problems and deal with difficulties. The choices that players make in terms of resource management determine their final scores and to some extent influence the pace of the game (use of networker). The goal of this mechanic is to enhance strategic thinking about real-life constraints and to present various activities that might be performed within an analytical unit.
4. Collaboration
   There are at least two types of in-game collaboration: the situation where success in a game action is achieved more quickly when played collaboratively and collaboration through discussion of game objectives (see Washmi et al. 2014). In the KB game, both types of collaboration are included. At the beginning, players receive five different pieces of information that describe various elements of the game in detail (e.g., research designs, policy actors, feeding methods, interventions, and general rules). It is very challenging for one person to comprehend all the delivered knowledge at once and perform all the necessary actions within the given time limit. Well-organized teams split the responsibilities between their members, so that each player specializes in a certain type of skills (e.g., research design specialist) and collaborates with his or her colleagues. That allows teams to complete tasks quickly and efficiently. At the same time, players need to have a general overview of the game's objectives and together discuss their overall strategy (like use of resources or dealing with unexpected situations). This kind of collaboration also enables the players to learn from one another instead of just from materials or the facilitator.
5. Unexpected events
   There are a number of unexpected events that take place between the rounds and influence the game play. Some of them are helpful and some obstruct a player's efforts. A few events are presented in the form of a dilemma in which players have to choose between alternatives. Each team has to estimate which alternative will better fit their current strategy and will eventually pay the predefined cost of their choice. As J. Schell (2014) put it, "Risk and randomness are like spices. A game without any hint of them can be completely bland, but put in too much and they overwhelm everything else." The KB game has a progression structure with a predefined scenario that determines the specific order of incoming "knowledge needs" and events. However, from a player's point of view, the events are unexpected and bring a sense of randomness that makes a game more unpredictable and interesting.

4 Conclusions and Future Steps

The workshop session was conducted with 16 participants divided into six teams, during 1 day's training, from 10 am to 3 pm. The results of the workshop have been evaluated based on the game results and discussion with participants. The findings are summarized in Table 4.

Table 4 shows that the simulation successfully addressed most of the learning goals. In the comments players also underlined that the game project was realistic, especially with regard to time pressure and the randomness of political influence. Elements of the game mechanics such as comparisons between teams and feedback after each round also worked well.

However, what emerged from the results is the fact that players clearly missed the issue of knowledge credibility. For this brokering skill, players were not able to move beyond reactive behaviors and create mental models that would allow them to grasp the systemic relation between research questions and research designs. When asked about this issue, participants pointed at two aspects. First, the issue of research design was relatively new to them. Although it is well established in research practice, it is an emerging issue in the practice of government analytical units. Second, teams felt they did not have enough time to properly analyze, discuss, and reflect fully on the feedback that arrived during the sessions.

These results lead the authors of the game to the conclusion that the game design works well but that it should be integrated into a more coherent educational experience. Therefore, three further improvements in the workshop design are required. First, players should be provided with a preparatory reader that includes materials and examples of research design in the practice of public policy studies. This would allow players to get familiar with this new and challenging concept.

Second, teams should be given more time for their internal discussion after getting the feedback in each round. This would allow them to proceed with more group inquiry of system patterns and search for explanations.

Third, facilitators of the workshop should devote more attention in debriefing sessions to issue of research designs. The workshop should include at least three debriefing sessions, not only one at the end of the game. They could be designed as mini-lectures with a questions and answers part (Q&A). They would be aimed at group reflection on effective strategies of knowledge brokering. Participants, guided by questions and comments posed by the facilitator, (a) could discover the relations and mechanisms underlying the dynamics of evidence use in public decision-making, (b) would reflect on their own strategies implemented during the game, and (c) could develop new solutions to be tested further in the course of the game.

This last discovery from the workshop is in line with recent literature that underlines the importance of proper debriefing for the experiential learning and reasoning of adult professionals (Crookall 2010; Kato 2010; Kriz 2010). An idea for a modified workshop agenda is presented in Table 5.

Table 4 Assessment of obtained learning goals

Key skills of knowledge broker	Discovered by players	Missed by players
(1) *Understanding knowledge needs*		
(1a) Recognizing stages of the intervention	**X**	
(1b) Recognizing actors' involvement	**X**	
(1c) Translating needs into questions		**X**
(2) *Acquiring credible knowledge*		
(2a) Matching questions with research designs		**X**
(2b) Matching designs to topics of intervention		**X**
(3) *Feeding knowledge effectively to users*		
(3a) Matching feeding methods to users	**X**	
(3b) Combining forms with channels		**X**
(4) *Building evidence-based foundations*		
(4a) Building a coherent argument	**X**	
(4b) Understanding limited influence	**X**	
(5) *Managing an evaluation unit*		
(5a) Scope and sequence of KB activities	**X**	
(5b) Management of resources – time and staff	**X**	
(5c) Using a proactive approach	**X**	

Table 5 Modified agenda of the workshop on knowledge brokering

10 min	Introduction to the workshop aim
30 min	Explanation of the rules of the game
20 min	Training round 1 and clarification
30 min	Rounds 2–3
10 min	Break
10 min	Presentation of partial results
30 min	First debriefing session: mini-lecture on knowledge needs and research designs, Q&A, group internal deliberation
40 min	Rounds 4–6
30 min	Break
10 min	Presentation of partial results
20 min	Second debriefing session: mini-lecture on types of users and feeding methods, Q&A, group internal deliberation
40 min	Rounds 7–10
15 min	Break
15 min	Presentation of final results and choice of the winners
30 min	Final debriefing session and takeaway points for real-life practice
30 min	Evaluation of the game – the learning process itself

To conclude, the application of a serious game proved to be a promising tool for teaching knowledge brokering to public policy practitioners. The game structure and mechanics worked well. The workshop structure (team internal reflection after feedback, debriefing) requires further calibration to create a fully integrated and experiential learning experience.

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References

Adams, E., & Dormans, J. (2012). *Game mechanics: Advanced game design*. Berkeley: New Riders.

Banks, G. (2009, February 4). *Evidence-based policy-making: What is it? How do we get it?* Proceedings from ANZSOG/ANU Public Lecture Series, Canberra.

Barrados, M., & Mayne, J. (2003). Can public sector organisations learn? *OECD Journal on Budgeting, 3*(3), 87–103.

Bots, P., Wagenaar, P., & Willemse, R. (2010). Assimilation of public policy concepts through role-play: Distinguishing rational design and political negotiation. *Simulation & Gaming, 41* (5), 743–766.

Caluwe, L., Geurts, J., & Kleinlugtenbelt, W. J. (2012). Gaming research in policy and organization: An assessment from the Netherlands. *Simulation & Gaming, 43*(5), 600–626.

Cartwright, N. (2013). Knowing what we are talking about: Why evidence doesn't always travel. *Evidence & Policy, 9*(1), 97–112.

Cartwright, N., & Hardie, J. (2012). *Evidence-based policy: A practical guide to doing it better*. Oxford: Oxford University Press.

Clark, G., & Kelly, L. (2005) *New directions for knowledge transfer and knowledge brokerage in Scotland: Office of Chief Researcher Knowledge Transfer Team briefing paper*. Scottish Executive Social Research. Scottish Executive Social Research.

Crookall, D. (2010). Serious games, debriefing, and simulation/gaming as a discipline. *Simulation & Gaming, 41*(6), 898–920.

Dobbins, M., Robeson, P., Ciliska, D., Hanna, S., Cameron, R., O'Mara, L., DeCorby, K., & Mercer, S. (2009). A description of a knowledge broker role implemented as part of a randomized controlled trial evaluating three knowledge translation strategies. *Implementation Science, 4*, 23.

Felicia, P. (2011). *Handbook of research on improving learning and motivation through educational games: Multidisciplinary approaches*. Hershey: IGI Global.

Fischer, F. (2003). *Reframing public policy: Discursive politics and deliberative practices*. New York: Oxford University Press.

Gutierrez, R. (2010). When experts do politics: Introducing water policy reform in Brazil. *Governance, 23*(1), 59–88.

Hood, C. (2007). What happens when transparency meets blame-avoidance? *Public Management Review, 9*(2), 191–210.

Kato, F. (2010). How we think and talk about facilitation. *Simulation & Gaming, 41*(5), 694–704.

Kriz, W. C. (2010). A systemic-constructivist approach to the facilitation and debriefing of simulations and games. *Simulation & Gaming, 41*(5), 663–680.

Lin, Y.-H. (2012). Knowledge brokering for transference to the pilot's safety behavior. *Management Decision, 50*(7), 1326–1338.

Lomas, J. (2007). The in-between world of knowledge brokering. *BMJ, 2007*(334), 129–132.

Majone, G. (1992). *Evidence, argument, and persuasion in the policy process*. New Haven: Yale University Press.

Mavoa, H., Waqa, G., Moodie, M., Kremer, P., McCabe, M., Snowdon, W., & Swinburn, B. (2012). Knowledge exchange in the Pacific: The TROPIC (Translational Research into Obesity Prevention Policies for Communities) project. *BMC Public Health, 12*(552), 1–9.

McAneney, H., McCann, J. F., Prior, L., Wilde, J., & Kee, F. (2010). Translating evidence into practice: A shared priority in public health? *Social Science and Medicine, 70*, 1492–1500.

Nutley, S. M., Walter, I., & Davies, H. T. O. (2007). *Using evidence: How research can inform public services*. Bristol: Policy Press.

Olejniczak, K., Raimondo, E. & Kupiec, T. (2016). "Evaluation units as knowledge brokers: Testing and calibrating an innovative framework". *Evaluation, 22*(2), 168–189.

Oliver, K., Innvar, S., Lorenc, T., Woodman, J., & Thomas, J. (2014). A systematic review of barriers to and facilitators of the use of evidence by policymakers. *BMC Health Services Research, 14*, 2.

Pavlas, D. (2010). *A model of flow and play in game-based learning: The impact of game characteristics, player traits, and player states* (Fall 2010). A dissertation submitted for PhD in the Department of Psychology, University of Central Florida.

Penenberg, A. L. (2013). *Play at work: How games inspire breakthrough thinking*. New York: Penguin.

Sanderson, I. (2002). Evaluation, policy learning and evidence-based policy making. *Public Administration, 80*(1), 1–22.

Schell, J. (2014). *The art of game design: A book of lenses* (2nd ed.). London: A K Peters/CRC Press.

Shillabeer, A., Buss, T. F., & Rousseau, D. M. (Eds.). (2011). *Evidence-based public management: Practices, issues, and prospects*. Armonk: M. E. Sharpe.

Shulha, L. M., & Cousins, B. J. (1997). Evaluation use: Theory, research, and practice since 1986. *Evaluation Practice, 18*(3), 195–208.

Waqa, G., Mavoa, H., Snowdon, W., Moodie, M., Nadakuitavuki, R., Mc Cabe, M., & Swinburn, B. (2013). Participants' perceptions of a knowledge-brokering strategy to facilitate evidence-informed policy-making in Fiji. *BMC Public Health, 13*, 725.

Washmi, R., Baines, M., Organ, S., Hopkins, G., Blanchefield, P., & Busch, C. (2014). "Mathematics "problem solving through collaboration: Game design and adventure" In C. Busch (Ed.), *8th European Conference on Games Based Learning: ECGBL2014*, Berlin.

Weiss, C. H., & Bucuvalas, M. J. (1980). *Social science research and decision-making*. New York: Columbia University Press.

Willems, M., Post, M., van der Weijden, T., & Visser-Meily, A. (2013). Do knowledge brokers facilitate implementation of the stroke guideline in clinical practice? *BMC Health Services Research, 13*(434), 1–17.

Simulation of an Organization as a Complex System: Agent-Based Modeling and a Gaming Experiment for Evolutionary Knowledge Management

Jessica Gu, Hao Wang, Fanjiang Xu, and Yu Chen

Abstract An agent-based model is employed to simulate an organization as a complex adaptive system which reveals how organization creates value through evolutionary knowledge management by autonomous agents from the bottom up. One of the surprising findings indicates that organizational performance is non-monotonically improved by either knowledge creation or diffusion. Meanwhile, a gaming experiment is conducted to verify the model and collect empirical evidence for model enhancement. Various causal relations among agents' behavior, the turbulence of environment, the emergent social structure, and the organizational performance are elucidated. This study demonstrates the integration of multi-agent simulation and human experiment as a novel, robust, and scientific approach on tackling complexity and uncertainty involved in the field of knowledge management.

Keywords Knowledge management • Agent-based modeling • Organizational behavior • Human experiment • Gamification

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1 Introduction

In the knowledge-based view or the knowledge-based theory of organization (Conner 1991; Demsetz 1988; Conner and Prahalad 1996; Kogut and Zander 1992, 1996; Grant 1996; Madhok 1996; Foss 1966a, b; Nahapiet and Ghoshal 1998; and Nickerson and Zenger 2004), knowledge is regarded as the ultimate source of value creation, and competitive advantages (Addicott et al. 2006). This is also the case for nations and regions (Toffler 1990; Drucker 1993). Knowledge management (KM) has been formally established as a multidisciplinary field of study in 1991 for achieving organizational purposes by making the best use of knowledge (Nonaka 1991). Knowledge creation (or generating) and knowledge diffusion (or sharing/exchange) are of primary concerns of organizations on the problem-solving perspective (Nickerson and Zenger 2004).

KM has been fueled by methodologies such as questionnaire survey, observation and interviews, sense-making narratives, case studies, and social network analysis. Numerous advanced data and information technologies or expert systems also facilitate KM in organizations. However, difficulties have been identified in both theory advancement and industrial applications for linking KM with organizational behavior and performance under a complex and uncertain environment. Additionally, approaches which address behavioral or evolutionary KM and the systemic causality are barely found in the literature (Alavi and Leidner 2001; Liao 2003; Kakabadse et al. 2003; Kane et al. 2005; Xu et al. 2008; Nemani 2009).

To break through such a bottleneck and tap into the complexity paradigm for next-generation KM development, the newly and rapidly popularized agent-based simulation is considered to be a promising solution. An agent-based model (ABM) is a computer model for simulating autonomous agents and assessing the system as a whole based on the generated effects from agents' interactions. ABM is a kind of microscale model (Gustaffsson and Sternad 2010) that is used in simulating the simultaneous operations and interactions of multiple agents in an attempt to recreate and predict the appearance of complex phenomena. ABM offers the possibility of modeling individual heterogeneity, representing explicitly agents' adaptive rules for decision making, generating social interaction and evolution, and situating agents in a geographical or another type of space (Gilbert 2008). Its favorable features include modularity, great flexibility, large expressiveness, and possibility to execute in a parallelized way (Taber and Timpone 1996). Therefore, it fits to the niche when simulating an organization as a complex adaptive system and examining the KM evolution are desired. Nevertheless, there are notable limitations on ABM, such as the validity of the modeled human behavior, the difficulties in reasonable parameter calibration and model self-validation, etc. On one hand, in the physical science of complexity, these difficulties are usually overcome by controlled experiments. On the other hand, in social science, the utilization of controlled human experiment can also be applicable. Indeed, controlled human experimentation is largely employed in psychology and socioeconomics to understand human behaviors, strategic decisions, interactive learning, and social preferences. It also should be a powerful methodology in KM organizational studies. However, to produce statistically meaningful results, millions of repetitions of experiments are required which can be extremely resource and time consuming; additionally, many influential variables of human traits are not feasibly to be controlled, e.g., preferences, freewill, and optimistic or pessimistic mood, which may lead to systemic errors. While in the simulation, these experiment constraints can be easily eliminated. Therefore, it is argued that the only solution is *the integration* of simulation and controlled human experiments.

The objective of this research is to establish a new methodological alternative through combining simulation and controlled human experiment in managing organizational knowledge under complex and uncertain environment. In this study, a multi-agent simulation is performed based on a previous model (Chang 2005) to explain how knowledge workers solve problems and achieve optimized performance by either creating new knowledge (innovation) or acquiring shared knowledge (imitation) from others through the social network. Meanwhile, a human gaming experiment is designed and conducted to verify the simulation model and to collect empirical evidence for the future model enhancement. Various causal relations among agents' behavior, the turbulence of environment, the emergent social structure, and the organizational performance are elucidated. Furthermore, the significance of the integrated approach on the KM study is discussed.

The paper is organized as follows: The first section introduces the research background, problem statements, and objectives. The second section explains the details of the ABM. The third and fourth sections demonstrate the simulation and experimental study design, implementation, and results, respectively. The fifth section discusses one of the interesting findings and pinpoints methodological advantages. Lastly, the sixth section concludes the achievement of this study and suggests future work directions.

2 The Agent-Based Model

In the agent-based model, an organization is considered as a complex adaptive system evolving with the environment. Individual knowledge workers are making KM effort to achieve better performance when facing various tasks with a freedom of choice on either innovation or imitation in the context of a turbulent task environment. For innovation, agents create new knowledge on their own, whereas for imitation, agents connect to the social network and acquire shared knowledge through social learning. Each individual must utilize the chance and choose strategically between innovation and imitation. During each time period, the likelihood of both actions is updated based on reinforcement learning. The model allows an examination of the emergent structure as well as a track of evolving choices between innovation and imitation.

2.1 Modeling the Agent

There are N agents in a simulated organization. Each agent $i \in \{1, 2, \ldots, N\}$ faces H tasks. The solutions chosen by an agent for a given task are represented by a sequence of d bits, either 0 or 1; hence, there are 2^d possible solutions available for each task. Denote $\boldsymbol{s}_i(t) \in \{0,1\}^{Hd}, \boldsymbol{s}_i(t) \equiv (\boldsymbol{s}_i{}^1(t), \ldots, \boldsymbol{s}_i{}^H(t))$, which is the vector of agents' solutions, and $\boldsymbol{s}_i^h(t) \equiv \left(s_i^{h,1}(t), \ldots, s_i^{h,d}(t)\right) \in \{0,1\}^d$ which is agent i's solution for task $h \in \{1, \ldots, H\}$.

The heterogeneity of agents is represented by how different their solutions are to the same task. To quantify the degree of heterogeneity between two agents (i and j), the hamming distance is employed as the following:

$$D\left(\boldsymbol{s}_i, \boldsymbol{s}_j\right) \equiv \sum_{h=1}^{H} \sum_{k=1}^{d} \left| s_i^{h,k} - s_j^{h,k} \right|. \tag{1}$$

Corresponding to each task, there is a goal vector $\hat{\boldsymbol{s}}_i(t) \in \{0, 1\}^{Hd}$. Note that $\hat{\boldsymbol{s}}_i(t)$ may be different from period t to period t+1 indicating the turbulence of task environment. Goal vectors may also vary among agents, implying the diversity of tasks for agents. The performance of agent i denotes $\pi_i(t)$:

$$\pi_i(t) = H \cdot d - D(\boldsymbol{s}_i(t), \hat{\boldsymbol{s}}_i(t)), \tag{2}$$

which is measured by the hamming distance between the goal and the solution.

2.2 The Evolutionary Knowledge Management

The framework of the agent-based organizational KM model is illustrated in Fig. 1. At each period t, a task is randomly allocated by the organization to each agent from the turbulent environment. Agent i has a chance to update his/her solution for moving closer to the goal (shortening the hamming distance) by either innovation or imitation.

Denote μ_i^{in} as the innovation productivity of individuals and μ_i^{im} as the accessibility of the social network. Under probability μ_i^{in}, agent i can create a new knowledge, while under probability $1 - \mu_i^{in}$, agent i fails the knowledge creation or stays idle. Under probability μ_i^{im}, agent i can connect to the social network and search for others, while under probability $1 - \mu_i^{im}$, agent i fails the network connection or stays idle. μ_i^{in} and μ_i^{im} are two exogenously specified parameters in the model.

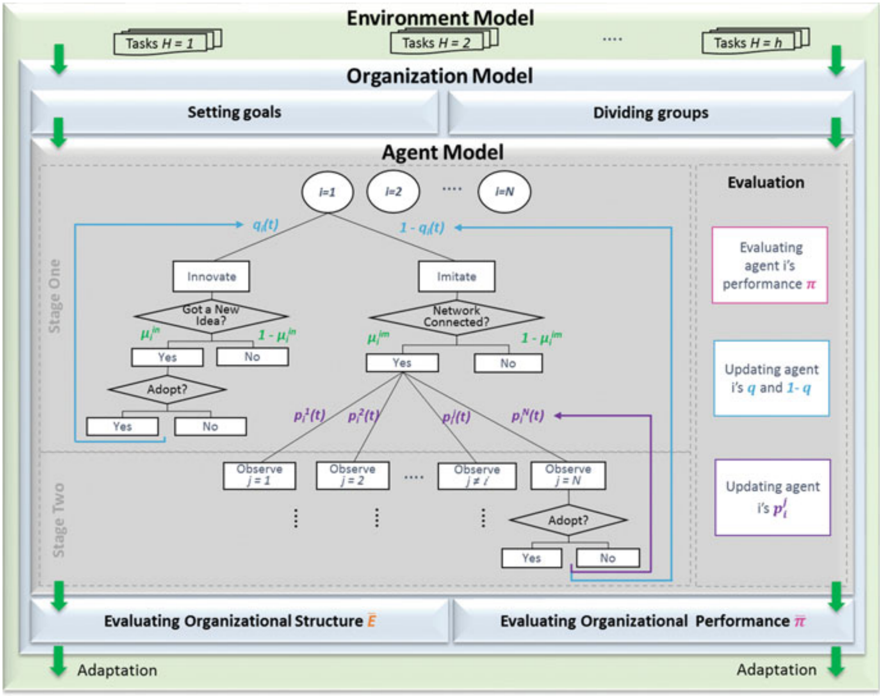

Fig. 1 The framework of the agent-based model

Assuming that agent i receives a goal vector $\hat{\boldsymbol{s}}_i(t)$ and has a current solution vector $\boldsymbol{s}_i(t)$, he/she can potentially obtain a new solution $\boldsymbol{s}_i'(t)$ by either innovation or imitation. Adoption or rejection of the created/learned is based on the following:

$$\boldsymbol{s}_i(t+1) = \begin{cases} \boldsymbol{s}_i'(t), & \text{if } D\left(\boldsymbol{s}_i'(t),\ \hat{\boldsymbol{s}}_i(t)\right) < D\left(\boldsymbol{s}_i(t),\ \hat{\boldsymbol{s}}_i(t)\right) \\ \boldsymbol{s}_i(t), & \text{if } D\left(\boldsymbol{s}_i'(t),\ \hat{\boldsymbol{s}}_i(t)\right) \geq D\left(\boldsymbol{s}_i(t),\ \hat{\boldsymbol{s}}_i(t)\right) \end{cases} \tag{3}$$

The evolution of the knowledge management of each agent is a two-stage process. The likelihood of innovation and imitation is updated in stage one, while the likelihood of social learning targets is updated in stage two both by experience-weighted attraction (EWA) (Camerer and Ho 1999) learning rule. In stage one, $q_i(t)$ is denoted as the probability that agent i chooses to innovate while 1-$q_i(t)$ as the probability that agent i chooses to imitate. Probability $q_i(t)$ is adjusted at each period on the basis of attraction measures, $B_i^{in}(t)$ and $B_i^{im}(t)$, for innovation and imitation correspondingly. The evolution of $B_i^{in}(t)$ and $B_i^{im}(t)$ is formulated as follows:

$$B_i^{in}(t+1) = \begin{cases} \phi B_i^{in}(t) + 1, & \text{if adopted} \\ \phi B_i^{in}(t), & \text{otherwise} \end{cases}, \quad (4)$$

$$B_i^{im}(t+1) = \begin{cases} \phi B_i^{im}(t) + 1, & \text{if adopted} \\ \phi B_i^{im}(t), & \text{otherwise} \end{cases}. \quad (5)$$

Hence, if the agent chose to pursue innovation and then adopted the newly created solution, the attraction measure for innovation would increase by one unit after allowing the previous attraction level to decay by the factor $\phi \in (0.1]$. Likewise, the update of attraction measure for imitation $B_i^{im}(t+1)$ applies the same way. Given $B_i^{in}(t)$ and $B_i^{im}(t)$, the agent then updates the choice probability of innovation as the following:

$$q_i(t) = \frac{\left(B_i^{in}(t)\right)^{\lambda}}{\left(B_i^{in}(t)\right)^{\lambda} + \left(B_i^{im}(t)\right)^{\lambda}}, \quad (6)$$

With $\lambda > 0$ as the agent's sensitivity to attraction. In stage two, the attractions and the probabilities are updated similarly. Let $A_i^j(t)$ be agent j's attraction to agent i in period t. It evolves as the following:

$$A_i^j(t+1) = \begin{cases} \phi A_i^j(t) + 1, & \text{if adopted} \\ \phi A_i^j(t), & \text{otherwise} \end{cases}, \quad (7)$$

with $\forall i, \forall j \neq i$. Denote $p_i^j(t)$ as the probability that agent i is likely to imitate agent j, and it is adjusted each period on the basis of the attraction measures $\left\{A_i^j(t)\right\}_{j \neq i}$:

$$p_i^j(t) = \frac{\left(A_i^j(t)\right)^{\lambda}}{\sum_{j \neq i}\left(A_i^j(t)\right)^{\lambda}}, \quad (8)$$

where $\lambda > 0$ is the sensitivity to attraction. Endogenously derived $q_i(t)$ and $p_i^j(t)$, and exogenously given parameters μ_i^{in} and μ_i^{im} are crucial for understanding the KM behavior of the whole organization.

2.3 Organization Model

As shown in Fig. 1, the organization model has two functions, namely, setting goals and dividing groups for the member agents and evaluating the organizational performance and structure.

Firstly, the scope of organizational goal is decided by setting the organizational goal seed vector $\boldsymbol{U}$. The intergroup tightness of the goals is controlled by R which is the maximum hamming distance to $\boldsymbol{U}$, so that $\Delta(\boldsymbol{U}, R)$ is the set of task vectors for the organization. As agents solve problems and move closer to their goals, the goal vectors are shifting as well. It is such a goal evolution that makes knowledge creation and diffusion vital. Secondly, in the organization, N agents are divided into G groups who have independent goal vectors determined by the organization initially, which means that different agents solve tasks in different domains. Let α_k be the set of agents belonging to group $k \in \{1, 2, \ldots, G\}$ and g_k be the seed vector used to generate the initial goal vectors for all agents,

$$\hat{\boldsymbol{s}}_i(0) \in \Delta\left(g_{k,}\ r\right),\ \forall i \in a_{\mathrm{k}},\ \forall \mathrm{k} \in \{1, 2, \ldots, G\} \tag{9}$$

where $\Delta(g_{k,}\ r)$ is a set whose "center" is g_k and r is the intragroup tightness of goals. All agents in α_k then have goal vectors which lie within hamming distance r to the group seed vector g_k. The heterogeneity among groups is modeled by allowing a diversified set of group seed vectors. Since the intergroup tightness of goals R is kept large enough while the intragroup tightness of goals r is significantly small, agents in the same group would face similar tasks, while agents in other groups would face different tasks. This is essential to the emergence of social learning structure in the organization.

The organizational model also includes the evaluation of the collective performance and the emergent organizational structure. The former is calculated as the following:

$$\overline{\pi}(t) = \frac{1}{N}\sum_{i=1}^{N}\pi_i(t) \tag{10}$$

Shannon's (1948) entropy $\bar{E}(t)$ is employed to measure the latter. With the entropy for each agent defined as:

$$E_i(t) = -\sum_{\forall j \neq i} p_i^j(t) \cdot \log_2 p_i^j(t), \tag{11}$$

the entropy for the whole organization can be calculated as follows:

$$\overline{E}(t) = \frac{1}{N}\sum_{i=1}^{N}E_i(t). \tag{12}$$

Note that the larger the $\bar{E}$, the less concentrated the network is.

2.4 Environment Model

The environmental turbulence is modeled by a stochastic process. In period t, assume that agent i has the current goal vector $\hat{\boldsymbol{s}}_i(t)$. In period t+1, his/her goal would stay the same with the probability σ, which stands for the intensity of turbulence in the environment, and shift with the probability $(1-\sigma)$. The shifting dynamics of the goal vector is guided by the following binomial process: The goal in period t+1, if different from $\hat{\boldsymbol{s}}_i(t)$, is then chosen *iid* (independently with an identical distribution) from the set of points that lie both within hamming distance ρ from $\hat{\boldsymbol{s}}_i(t)$ and within hamming distance r from the original group seed vector g_k. Consequently,

$$\begin{cases} \hat{\boldsymbol{s}}_i\,(t+1) = \hat{\boldsymbol{s}}_i(t) & \text{with pobability} \quad \sigma \\ \hat{\boldsymbol{s}}_i\,(t+1) \in\ \wedge\,(\hat{\boldsymbol{s}}_i(t),\ \rho,\ g_k\ , r) & \text{with probability } 1-\sigma \end{cases} \tag{13}$$

Note that ρ or less bits of the goal are randomly selected and flipped in the shifting process.

3 The Simulation

3.1 The Baseline Settings

The purpose of baseline simulation is to lay a foundation for the further exploration on how organizational performance and structure are influenced by individual's action, the environmental turbulence, and other factors. In the simulated organization, there are $N=6$ agents equally distributed in $G=2$ groups. For the baseline settings, $\mu_i^{in}=0.5$ and $\mu_i^{im}=0.5$ are deployed, so the efforts for agents to create a new knowledge by innovation or acquire a shared knowledge through social network are the same. The numerical values of other parameters and initial attractions are summarized in Table 1. Parameters μ_i^{in}, μ_i^{im}, ϕ, and λ govern an agent's decision-making behavior, while R, r, ρ, and σ control the task environment. Initially, either innovation or imitation is equally preferred by the agents. For imitation, agent's attraction to any other agents at the beginning is not biased as well.

3.2 Simulation Sessions

To explore how the steady-state behavior of the organization is influenced by different innovation productivities and social network accessibility, a series of simulated experimentations are carried out with the parameter settings listed in

Table 1 Notations of baseline simulation setting

Notation	Definition	Baseline value
H	Number of tasks for each agent	12
d	Bits in each task/goal and solution	4
R	Intergroup tightness of goals	16
r	Intragroup tightness of goals	8
$1-\sigma$	Intensity of environmental turbulence	0.25
ρ	Inter-temporal goal variability	2
ϕ	Attraction decay factor	1
λ	Agent's sensitivity to attraction	1
$B_i^{in}(0), \forall i$	i's attraction to innovation at $t=0$	1
$B_i^{im}(0), \forall i$	i's attraction to imitation at $t=0$	1
$A_i^j(0), \forall i, \forall j \neq i$	i's attraction to j at $t=0$	1

Table 2. Simulation 1 and 2 are designed with relatively easy and difficult KM contexts to cross-check the results with the baseline neutral settings. Simulation 3–6 are performed to examine how organizational performance is influenced by the accessibility of the social network, while the productivity of innovation is fixed low reflecting the fact that innovation is more difficult in the reality. The simulation is carried out for 20 runs, each with the same duration ($t = 10{,}000$) and the same parameter settings but initialized with different seeds for random numbers. To eliminate noise from the randomness in the initial conditions and goal shifting, results are averaged over all runs.

3.3 Simulation Results

As shown in Fig. 2a, b, there is no significant difference in results among relatively easy, difficult, and the baseline neutral KM contexts. For all three cases, the organizational performance is greatly improved through agents' effort on creating new knowledge and sharing existing knowledge, then maximized and stabilized. Meanwhile, the organizational structure is emerged and stabilized as the entropy decreases. For the baseline case, the time evolution of the averaged social attraction $p_i^j(t)$ is calculated and plotted in Fig. 3, where the black diagonal grids indicate that agents do not learn from themselves, while the light grids indicate a strong social learning from agents listed on the horizontal axis to those on the vertical axis. The time change of the structural pattern indicates a strong intragroup learning than intergroup learning. For the relatively easy KM context ($\mu_i^{in} = 0.8, \mu_i^{im} = 0.8$), the structure is emerged faster and the structural pattern is clearer, whereas, for the relatively difficult KM context ($\mu_i^{in} = 0.25, \mu_i^{im} = 0.25$), the structure is emerged slower and the structural pattern is blurrier as can be confirmed through the time variation of entropy in Fig. 2b.

Table 2 Experimenting different parameters in simulation

Simulation sessions	Innovation (μ_i^{in}) productivity of new solution	Imitation (μ_i^{im}) accessibility of social network
Baseline	0.5	0.5
Simulation 1	0.8	0.8
Simulation 2	0.25	0.25
Simulation 3	0.25	0.05
Simulation 4	0.25	0.3
Simulation 5	0.25	0.5
Simulation 6	0.25	0.8

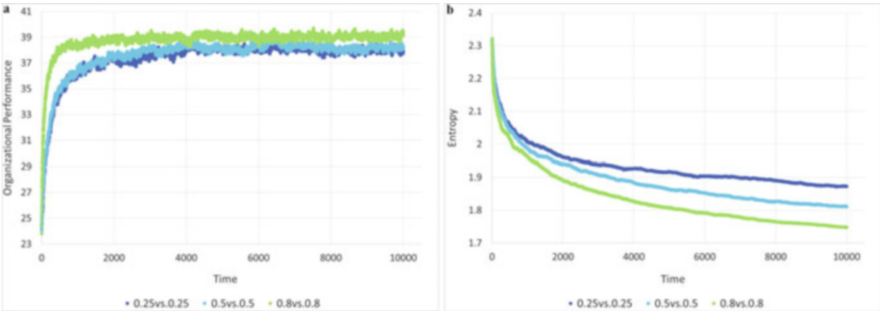

Fig. 2 (**a**) Organizational performance. (**b**) Entropy of structure formation

One of the surprising findings from simulations 3–6 shows a non-monotonicity in the steady-state organizational performance versus the accessibility of social networks. When the productivity of new solutions μ_i^{in} is fixed low to 0.25, the accessibility of social networks is gradually increased from 0.05 to 0.8. As shown in Fig. 4, the averaged organizational performance of the simulation sessions is not improved monotonically alongside the increment of network accessibility. Instead, it peaks at simulation 5 and then falls down at simulation 6. In other words, a high accessibility of social networks can be harmful to the organizational performance. Note that standard deviations of organizational performance keep nearly constant as shown in error bars (less than 0.28), inferring that the discovered non-monotonicity is robust and reliable.

4 The Human Gaming Experiment

4.1 The Computer-Supported Gaming Sessions

The purposes of the computer-supported human gaming experiment include verification of the developed model on the system level, observation of human behavior

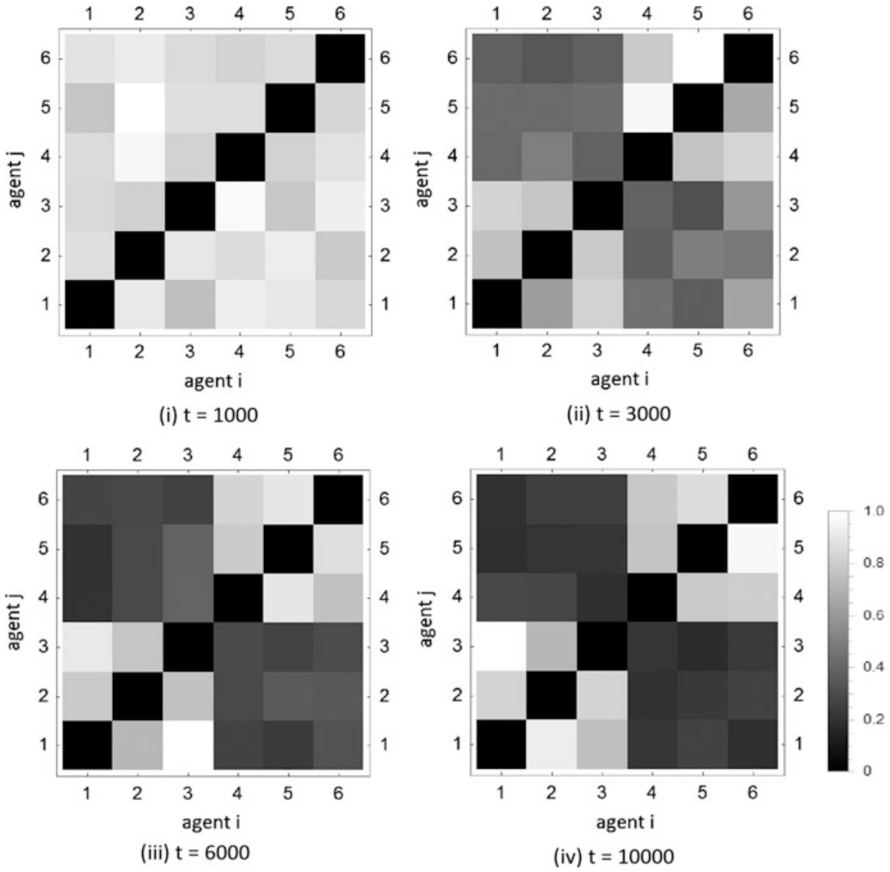

Fig. 3 Intragroup learning vs. intergroup learning of agents

in reality for model enhancement on the individual level, and identification of factors that may potentially and crucially influence human decision making and organizational performance. The experiment is designed as an online game challenged by human participants. A gaming software is developed in accordance with the same configurations and flows as those in the agent-based model shown in Fig. 1. It is written in Java and has four modules including player interface, control panel, computational engine, and database. Player interface allows participants to manage their accounts, utilize the real-time gaming information to form strategies, and experience a competition and cooperation environment. Screenshots of the game interface are shown in Fig. 5. Like agents in ABM, each participant has to compete with one another making KM efforts to gain the highest score. Control panel allows the game administrator to manipulate parameters, game rounds, and information access rights. Computational engine is responsible for task allocation, hamming distance evaluation, player score calculation, and environmental

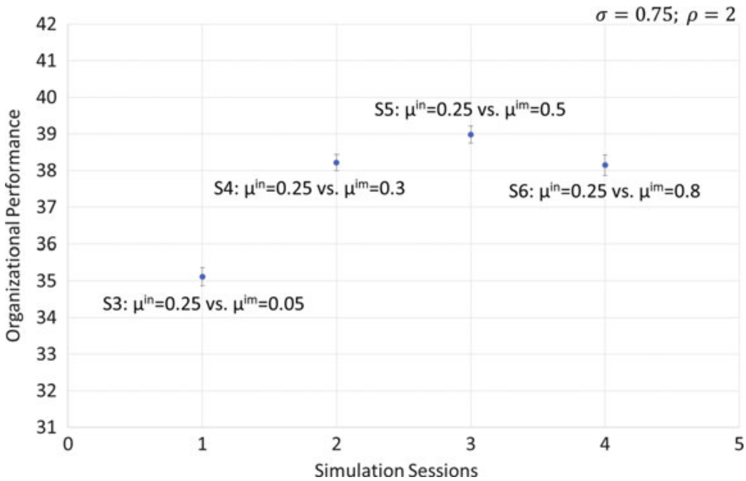

Fig. 4 Non-monotonicity of organizational performance in simulation

Fig. 5 Screenshots of the experiment

turbulence generation. Lastly the database stores all the events and transactions for analysis.

The gaming sessions are executed in the same settings with the simulation sessions except the one with relatively difficult KM context ($\mu_i^{in} = 0.25, \mu_i^{im} = 0.25$) because results would be unreliable in consideration of the possible frustrated emotional reactions of players. Thus, there are six gaming sessions played in total as shown in Table 3. Thirty-six graduate students coming from the Institute of Software, Chinese Academy of Sciences participated in the experiment as volunteers. For one gaming session, six players are randomly divided into two groups.

Since the timespan in the experiment is completely different from the simulation, deciding the number of rounds for each game is crucial. Several trial games were played for round number determination and game software testing. Finally, 80 rounds for games 1–2 and 200 rounds for games 3–6 are decided, since they are sufficient to reach the steady state for evaluation and economically affordable in terms of time and manpower. Meanwhile, to shorten the individual searching and

Table 3 Different parameters in gaming sessions

Gaming sessions	Innovation (μ_i^{in}) productivity of new solution	Imitation (μ_i^{im}) accessibility of social network
Game 1	0.8	0.8
Game 2	0.5	0.5
Game 3	0.25	0.05
Game 4	0.25	0.3
Game 5	0.25	0.5
Game 6	0.25	0.8

testing time when forming strategies, participants are informed with μ_i^{in} and μ_i^{im} in advance. They are also clear that players in the same group are assigned with similar tasks, while players in the other group have far different ones. In other words, at the beginning of the game, participants understand that intragroup learning is more efficient than intergroup learning. In contrast, only through numerous iterations of reinforcement learning can such insight be realized by autonomous agents in the simulation.

4.2 *Results of the Experiment*

One result of gaming sessions, from the baseline game 2, is shown in Fig. 6. This indicates that along with participants' KM effort on innovation or imitation, the organizational performance is improved gradually, and then it reaches a peak and stays stabilized. This progress qualitatively agrees with the simulation result but shows a much faster convergence to the steady state. This means that the pregame briefing session with information on $\mu_i^{in}$and μ_i^{im} and group task differences is necessary and effective. Different from the simulation, organizational performance in the steady state is lower and more fluctuated. The reason can possibly lie in low human engagement, poor learning efficiency, and fatigue. Heuristics rather than perfect rationality in decision making can also be the cause.

At the steady state, the structural pattern is captured in Fig. 7 for game 2, revealing that players with similar goals hold higher tendency to learn among each other instead of reaching out for solutions in the other group. Bubble size indicates the frequency which players on horizontal axis choose players on vertical axis. The larger the bubble, the stronger the social learning is. Two distinct groups A and B can be identified. Although there is some noise caused by intergroup learning, the overall pattern matches the simulation results (Fig. 3iv) well.

After the completion of games 3–6, each steady-state organizational performance value is calculated and plotted in Fig. 8, showing a non-monotonicity as well, similar but stronger than the one in the simulation. With low innovation productivity, gradually increasing the accessibility of the social network can enhance the collective performance until a certain point; however, when further

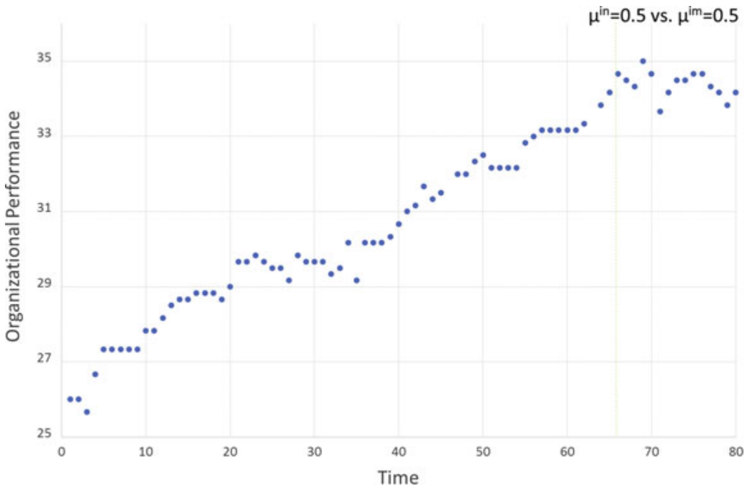

Fig. 6 Organizational performance in game 2

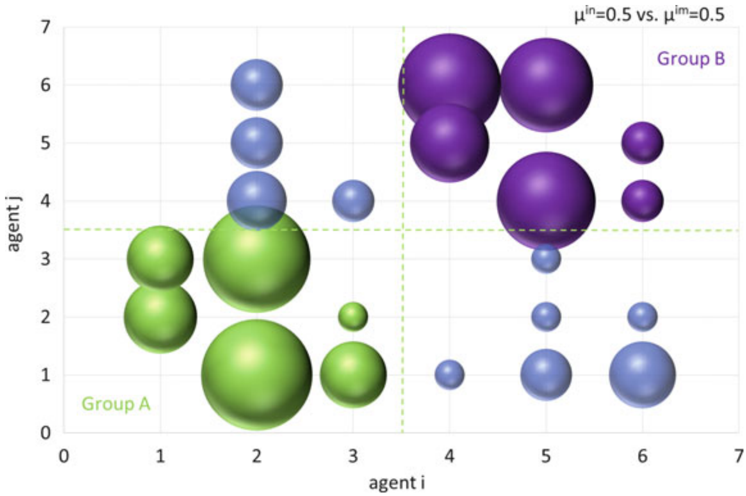

Fig. 7 Emergent social structure and social learning

increased, it can be harmful to the organizational performance. Moreover, the noteworthy turning point ($\mu_i^{in} = 0.25, \mu_i^{im} = 0.5$) is in accordance with the simulation, except that standard deviations are larger.

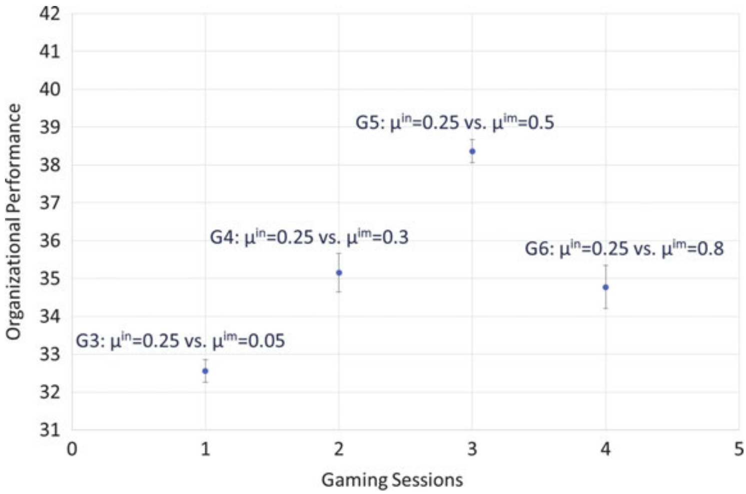

Fig. 8 Non-monotonicity of organizational performance in experiment

5 Discussion

5.1 Why Non-monotonicity Occurs?

Interestingly, results from both simulation and gaming sessions reveal non-monotonicity in organizational performance alongside social network connectivity increments. In other words, organizational performance is not enhanced and optimized by either innovation or imitation alone, but both. When the innovation productivity is fixed to $\mu_i^{in} = 0.25$, increasing social network accessibility as $\mu_i^{im} = 0.05$, $\mu_i^{im} = 0.3$, $\mu_i^{im} = 0.5$, $\mu_i^{im} = 0.8$ not always allows the organizational performance to continually strike. Both the simulation and the experiment reach a peak in the organizational performance at $\text{S5} : \mu_i^{in} = 0.25,\ \mu_i^{im} = 0.5$ and then a decline at $\text{S6} :\ \mu_i^{in} = 0.25,\ \mu_i^{im} = 0.8$. Now the question is why it happens. This phenomenon can be elaborated as the following: When social network accessibility is increasing, agents tend to engage more and more in social learning, sharing existing knowledge among one another, rather than creating new knowledge by innovation, since imitation is relatively easier than innovation. However, when social learning engagement is too strong, there will not be enough new knowledge created in the organization due to less innovation engagement. Gradually, the systemic diversity in agents' solutions is fading away, while the environmental turbulence is still strong enough to bring in brand-new and diverse problems. Under such a fatal situation, the organizational performance inevitably declines. Thus, the non-monotonicity should depend on the turbulence of the environment. The more turbulent the environment, the more innovation efforts are needed for solving new problems. To investigate the influence of environmental turbulence on the

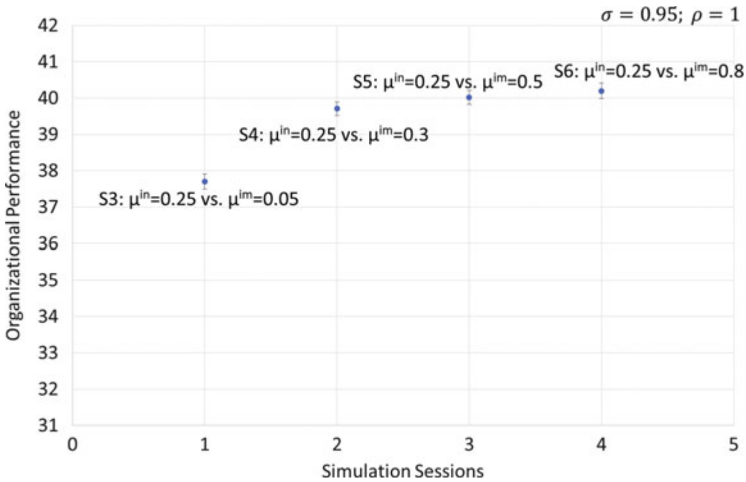

Fig. 9 Monotonicity under stable environment

non-monotonicity, another set of simulation sessions are carried out under a relatively stable environment. This time, the intensity of environmental turbulence 1–σ is tuned from 0.25 to 0.05, while the inter-temporal goal variability ρ is tuned from 2 to 1. With such designs, simulations are performed with fixed $\mu_i^{in} = 0.25$, and incrementally increased social learning accessibility $\mu_i^{im} = 0.05$, $\mu_i^{im} = 0.3$, $\mu_i^{im} = 0.5$, $\mu_i^{im} = 0.8$. The results shown in Fig. 9 indicate that the organizational performances under the stable environment continuously strike without any decline. Moreover, the overall organizational performances are higher and the standard deviations are lower (less than 0.22), because sharing existing knowledge among agents is good enough for solving recurrent problems.

5.2 *Empirical Evidence from Gaming Experiment*

Experiment offers rich empirical information including human behavioral decision making in the real situation. Unlike computer agents, human beings are not always stringently rational. As shown in Fig. 7, only player 1 on the horizontal axis always learns intragrouply while others all attempt intergroup learning. Even the information, intragroup learning is more helpful, has been given. More surprisingly, player 6 on the horizontal axis learns more intergrouply than intragrouply, revealing a strong violation of rationality. Whether the irrational behaviors are due to the curiosity, social preference, or heuristics, so far it cannot be confirmed. Yet, it suggests a need for reexamining the reinforcement learning rule in ABM. Therefore, the gaming experiment provides a crucial support for model improvement in the future.

5.3 The Integration of Simulation and Human Experiment

One of the unique characteristics and advantages of multi-agent simulation is the versatility. It can produce emerged macroscopic phenomenon based on the microscopic individual interactions and offer internal structure, process, and state scalable view of results for investigation. In this study, the simulation discovers the non-monotonicity in organizational performance which cannot be achieved using traditional costly qualitative or quantitative methodologies. Additionally, based on such a versatile tool, policy makers can design new strategies and policies for the organization, especially suitable for coping complex and turbulent competitive environment as problems become obsolete quickly and unpredictably. Meanwhile, unlike field work methodologies, the simulation does not need skillset prerequisites, sacrifice overhead cost, interrupt daily operations, or introduce panic to employees.

The advantages of controlled human experiment are highlighted in the previous section. Although simulation and experiment can be used as standalone methodology, both have limitations that can be overcome through integration. The simulation can be used as a roadmap for the experiment, while the experiment can be used for verification and refinement of the developed ABM with supplementary information from the reality. When integrated, as demonstrated in this study, both can reinforce and elevate each other delivering more insightful and reliable results for evolutionary knowledge management and organizational performance optimization.

6 Conclusion and Future Work

In summary, through combining the multi-agent simulation and the human experiment, a profound evolutionary KM methodology has been established. Two essential KM processes, namely, knowledge creation and diffusion, are successfully modeled and verified. The simulation offers rich and scalable results indicating that the organizational performance is enhanced with agents' effort on knowledge creation and diffusion. The organizational structure emerged from the bottom up and stabilized. Knowledge diffusion and social learning is more frequently observed intragrouply than intergrouply. Due to the uniqueness and robustness of the simulation, a non-monotonic phenomenon has been discovered. Further, results from the human gaming experiment confirm the developed ABM reliable and effective.

As discussed above, in the future, the reinforcement learning in the agent model needs to be improved based on the experiment so that it can more rigorously reflect the human behavioral decision making under uncertainty. For the organization model, the organizational adaptivity needs to be enabled so that it can interact with its member agents. Moreover, the organization performance can be further enhanced through establishing feedback links from systemic outcome and effectiveness to iterative interventions, e.g., new policies, new structure designs. Lastly, the environment model also needs to be upgraded by taking organization-environment interactions into account, so that the organization can constantly adapt to the environment and meanwhile reinvent the environment. Ultimately, human-organization-environment co-creation and coevolution can be realized.

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References

Addicott, R., McGivern, G., & Ferlie, E. (2006). Networks, organizational learning and knowledge management: NHS cancer networks. *Public Money & Management, 26*(2), 87–94.

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, *25*(1), 107–136.

Camerer, C., & Ho, T. H. (1999). Experience-weighted attraction learning in normal form games. *Econometrica, 67*, 827–8754.

Chang, M. H. (2005). Discovery and diffusion of knowledge in an endogenous social network. *American Journal of Sociology, 110*, 937–976.

Conner, K. R. (1991). A historical comparison of resource-based theory and five schools of thought within industrial organization economics: Do we have a new theory of the firm? *Journal of Management, 17*(1), 121–154.

Conner, K. R., & Prahalad, C. K. (1996). A resource-based theory of the firm: Knowledge versus opportunism. *Organization Science, 7*(5), 477–501.

Demsetz, H. (1988). The theory of the firm revisited. *Journal of Law, Economics, & Organization*, *4*(1), 141–161.

Drucker, P. (1993). *Post-capitalist society*. London: Butterworth Heinemann.

Foss, N. J. (1996a). Knowledge-based approaches to the theory of the firm: Some critical comments. *Organization Science, 7*(5), 470–476.

Foss, N. J. (1996b). More critical comments on knowledge-based theories of the firm. *Organization Science, 7*(5), 519–523.

Gilbert, N. (2008). *Researching social life*. London: Sage.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109–122.

Gustafsson, L., & Sternad, M. (2010). Consistent micro, macro and state-based population modelling. *Mathematical Biosciences, 225*(2), 94–107.

Kakabadse, N. K., Kakabadse, A., & Kouzmin, A. (2003). Reviewing the knowledge management literature: Towards a taxonomy. *Journal of Knowledge Management, 7*(4), 75–91.

Kane, H., Ragsdell, G., & Oppenheim, C. (2005). Knowledge management methodologies. In *2nd international conference on intellectual capital, knowledge management and organisational learning* (pp. 253–266). Dubai: Academic Conferences Limited.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383–397.

Kogut, B., & Zander, U. (1996). What firms do? Coordination, identity, and learning. *Organization Science, 7*(5), 502–518.

Liao, S. H. (2003). Knowledge management technologies and applications—literature review from 1995 to 2002. *Expert Systems with Applications, 25*(2), 155–164.

Madhok, A. (1996). Crossroads–The organization of economic activity: Transaction costs, firm capabilities, and the nature of governance. *Organization Science, 7*(5), 577–590.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review, 23*(2), 242–266.

Nemani, R. R. (2009). *Research methodologies used in knowledge management: A literature review*. MWAIS 2009 Proceedings, 13.

Nickerson, J. A., & Zenger, T. R. (2004). A knowledge-based theory of the firm—the problem-solving perspective. *Organization Science, 15*(6), 617–632.

Nonaka, I. (1991). The knowledge creating company. *Harvard Business Review, 69*, 96–104.

Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical Journal, 27*, 379–423, 623–656.

Taber, C. S., & Timpone, R. J. (1996). Computational modeling (No. 7–113). London: Sage.

Toffler, A. (1990). *Powershift: Knowledge, wealth and violence at the edge of the 21st century*. New York: Bantam Books.

Xu, J., Sankaran, G., Sankaran, S., & Clarke, D. (2008). Knowledge management in twenty-first century: Literature review and future research directions. *The International Technology Management Review, 1*(2), 16–24.

Appendices

Appendix A: ISAGA-JASAG 2015 Program

July 17
9:00–11:00 **Special Workshop**
Debriefing: The Real Learning Begins When the Game Stops
Tipton, Elizabeth J. (Eastern Washington University, USA)
Leigh, Elyssebeth (University of Wollongong, Australia)
Kritz Willy C. (Vorarlberg University of Applied Sciences, Austria)
Crookall, David (Vorarlberg University of Applied Sciences, Austria)

10:30–12:00 **JASAG Session 1**
Drill for Shelter Assessments in Time of Disaster
Manabu Ichikawa (National Institute of Public Health, Japan)
Knowledge Management of the Workshop on Regional Development by Means of Ontology Engineering
Terukazu Kumazawa (Research Institute for Humanity and Nature, Japan)
Michinori Kimura (Lake Biwa Environmental Research Institute, Japan)
Takanori Matsui (Osaka University, Japan)
An E-portfolio System to Support Research on the Development of Gaming Instructional Materials
Toshiki Matsuda (Tokyo Institute of Technology, Japan)

10:30–12:00 **JASAG Session 2**
Possibility of Local Monopoly
Mikihiro Ueda (Osaka Prefecture University, Japan)
Development of BASE Fishery Business Game
Ryoju Hamada (Sirindhorn International Institute of Technology, Thammasat University, Thailand)
Chiaki Iwai (Aoyama Gakuin University, Japan)
Tomomi Kaneko (Hokkaido University of Science Junior College, Japan)

T. Kaneda et al. (eds.), *Simulation and Gaming in the Network Society*,
Translational Systems Sciences 9, DOI 10.1007/978-981-10-0575-6

Masahiro Hiji (Tohoku University, Japan)
When are Players Aware of Rules in Games?
Junkichi Sugiura (Keio University, Japan)

13:15–14:45 **JASAG Special Session**
The Origin of Board Games and Ancient Game Boards
Koichi Masukawa (The chair of the Society of Game's History, Japan)

15:00–15:30 **ISAGA Opening**
Kickoff Address: Hidehiko Kanegae (Representative of the Organizing Committee)
Welcome Message: Hiroshi Deguchi (Representative of JASAG)
Acknowledgment Remark: Willy C. Kriz (Representative of ISAGA)
Congratulatory Speech by Guests of Honor: Yoichi Erikawa (Founder of FOST)
Greeting (only in text): Sebastiaan Meijer (Representative of ISAGA Executive Board)

15:30–16:30 **Keynote 1**
The Origins of Board Games and Ancient Game Boards
Koichi, Masukawa (The Society of Game's History, Japan)

16:45–17:45 JASAG Session 2
Chairman: Shinobu Kitani (Tohoku University, Japan)
Consensus Building for Agriculture Reconstruction in the 3.11 Disaster Area: Process of Starting an Agricultural Corporation in S Town, Miyagi Prefecture
Shin Oyama (Yamagata University, Japan)
Chinatsu Yonezawa (Tohoku University, Japan)
Yohei Nishida (Tohoku University, Japan)
The Role of Proposal Gaming for Community Building by Endogenous Development Theory in Afflicted Area
Yuta Kogure (Tohoku University)
Hiraku Kumagai (Tohoku University)
Shinobu Kitani (Tohoku University)

16:45–17:45 **ISAGA General Members Meeting Part 1**

18:00–20:00 **JASAG Game Ready to Play as Welcome Gaming Session and ISAGA Welcome Dinner**

July 18
9:00–10:00 **Keynote 2**
Building a Global Disaster Resilience Model
German Velasquez (UNISDR, Switzerland)

10:30–12:00 **Oral Presentation (Simulation and Gaming for Education 1)**
Cormas, an Agent-Based Simulation Platform for Coupling Human Decision with Computerized Dynamics
Bommel, Pierre (CIRAD – Green Research Unit – France)

Becu, Nicolas (CNRS – LIENSs – UMR 72663)
Le Page, Christophe; Bousquet, François (CIRAD – Green Research Unit – France)
BUILD-A-GAME An Educational Game Development Platform
Tan, Sun Teck (School of Computing, National University of Singapore, Singapore)
Simulation of an Organization as a Complex System – A Study of Evolutionary Knowledge Management Using Agent-Based Modeling and a Gamified Human Experiment
Gu, Jessica (The University of Tokyo, Japan)
Chen, Yu (The University of Tokyo, Japan)

10:30–12:00 **Oral Presentation** (Simulation and Gaming for Planning and Policy 1)
A Simulation Analysis of Regional Economic Recovery Assuming Nankai Trough Earthquake: A Case Study on Shima City
Cui, Mingji (Ritsumeikan University, Japan)
Taniguchi, Hitoshi (Intelligent Watching Camera Standardization Technical Committee, Japan Image Analysis Association)
Toyoda, Yusuke (Ritsumeikan University, Japan)
Kanegae, Hidehiko (Ritsumeikan University, Japan)
A Game of Knowledge Brokering: New Approach for Strengthening Evidence-Based Policies
Olejniczak, Karol (University of Warsaw, Poland)
Kupiec, Tomasz (EGO s.c., Poland)
Widawski, Igor (PGS, Poland)
Policy Gaming for Strategy Intervention in Slum Community, Thailand
Denpaiboon, Chaweewan (Thammasat University, Thailand)

10:30–12:00 **Special Session 1 Time Capsule of Gaming Simulation: Back to the Future of ISAGA**
Willy C. Kritz (Vorarlberg University of Applied Sciences)

12:00–13:15 **Poster Presentation (Contents are Cited in the End of This Appendix)**

13:15–14:45 **Oral Presentation** (Simulation and Gaming for Education 2)
Multiplayer Online Role-Playing Games as Information Systems: Implications for Organizational Learning
Harviainen, J. Tuomas (University of Tampere, Finland); Vesa, Mikko (Aalto University, Finland)
Understanding and Changing Systems Through Hybrid Simulation Game Design Methods in Educational Contexts
Kriz, Willy C. (Vorarlberg University of Applied Sciences, Austria)
Manahl, Werner (Vorarlberg University of Applied Sciences, Austria)
Live-Action Role-Play or the Performance of Realities
Kamm, Bjoern-Ole (Kyoto University, Japan); Becker, Julia (Dortmund University, Germany)

13:15–14:45 **Oral Presentation 2** (Simulation and Gaming for Planning and Policy 2)

Synchro Mania – Design and Evaluation of a Serious Game Creating a Mind Shift in Transport Planning

Buiel, Erik (TNO, the Netherlands)
Visschedijk, Gillian (TNO, the Netherlands)
Lebesque, Layla (TNO, the Netherlands)
Lucassen, Inge (TNO, the Netherlands 1)
van Riessen, Bart (ECT, the Netherlands)
van Rijn, Arno (ECT, the Netherlands)
te Brake, Guido (TNO, the Netherlands)

What Do Policy Makers Talk About When Talking About Simulations?

Raghothama, Jayanth (KTH Royal Institute of Technology, Sweden)
Meijer, Sebastiaan (KTH Royal Institute of Technology, Sweden)

Using Simulation Games as Research Instruments: Lessons Learned from the Transportation Domain

Lukosch, Heide Karen (Delft University of Technology, the Netherlands
Groen, Daan (In There, the Netherlands)
Kurapati, Shalini (Delft University of Technology, the Netherlands)
Verbraeck, Alexander (Delft University of Technology, the Netherlands)

13:15–14:45 **Oral Presentation** (Simulation and Gaming for Psychology and Communication 1)

Cognitive Learning Effectiveness with Mobile Serious Games in Adult Education

Wardaszko, Marcin (Kozminski University, Poland)
Podgórski, Błażej (Kozminski University, Poland)

A Basic Research of Gifts Made by Pure Donations Without Expectation of Any Returns to Analysis Unconditional Kindness is to Redefine Some "Rational" of Social Dilemma

Haruka Suzuki (OIC Research Organization of Ritsumeikan University, Japan)

Introduction of Gaming and Simulation in a University Social Psychology Class

Kikkawa, Toshiko (Keio University, Japan)

13:15–14:45 **Oral Presentation** (Simulation and Gaming for Business, Marketing, and Organizational Behavior 1)

ColPMan: A Serious Game for Practicing Collaborative Production Management

Mizuyama, Hajime (Aoyama Gakuin University, Japan)
Nonaka, Tomomi (Aoyama Gakuin University, Japan)
Yoshikawa, Yuko Aoyama Gakuin University, Japan)
Miki, Kentaro (Aoyama Gakuin University, Japan)

Study of Attractiveness of Bidding Exercise to Find One Value of Analog Business Games

Kaneko, Tomomi (Hokkaido University of Science Junior College, Japan)

Hamada, Ryoju (Sirindhorn International Institute of Technology, Thammasat University, Thailand)
Hiji, Masahiro (Accounting School, Tohoku University, Japan)
A Research Road Map for Serious Games in Companies
Riedel, Johann C.K.H (BIBA, Germany)
Baalsrud Hauge (Royal Institute of Technology, Sweden)
Jannicke M. (University of Nottingham)
Padron Naploes, Carmen L. (ATOS, Spain)

15:15–16:15 **Workshop WS 1.2.3**

16:30–18:30 **Workshop WL 1.2.3.4**

19:00–20:00 **Welcome Kyoto – Cocktail Party – (with the Compliments of ISAGA/JASAG)**

July 19
9:00–10:00 **Keynote 3**
Hybridity of Multiple Realities on our Life World and How to Construct New Realities and Its Accommodation
Deguchi, Hiroshi (Tokyo Institute of Technology)

10:30–12:00 **Oral Presentation** (Simulation and Gaming For Psychology and Communication 2)
Social Dilemma as a Device for Recognition of Shared Goal: Development of "Consensus Building of Wind Farm Game"
Ohnuma, Susumu (Hokkaido University, Japan)
Kitakaji, Yoko (Hokkaido University, Japan Society for the Promotion of Science, Japan)
Even Unreliable Information Disclosure Makes People Cooperate in a Social Dilemma: Development of the "Industrial Waste Illegal Dumping Game"
Kitakaji, Yoko (Hokkaido University, Japan Society for the Promotion of Science, Japan)
Ohnuma, Susumu (Hokkaido University, Japan)
Ecological Psychology – A Framework for War Game Design
Granberg, Staffan (Swedish Defence University, Sweden)
Hulterström, Patrik (Swedish Defence University, Sweden)

10:30–12:00 **"Postdoctoral Consortium" Section**
Organizer: Titton, Luiz A. (University of São Paulo, Brazil)

10:30–12:00 **Special Session 2: A Hybrid Model for Consensus Building – Case Study of Waste Management Plan in Nagoya, Japan**
Sachihiko Harashina (Chiba University of Commerce, Japan)

12:00–13:15 **Poster Presentation (Contents are Cited in the End of This Appendix)**

13:15–14:45 **Oral Presentation** (Simulation and Gaming for Education 3)

The Use of Origami in Serious Games
Cuesta Aguiar (Keio University, Japan), Victor Alonso (Keio University, Japan)
Nakano, Masaru (Keio University, Japan)
Mobile Educational Game – Smart Leo
Podgorski, Blazej (Kozminski University, Poland); Wardaszko, Marcin (Kozminski University, Poland)
Gamification in Education: "American Dream" Game
Pikos, Anna Marta (Kozminski University, Poland); Olejniczak, Tomasz (Kozminski University, Poland)

13:15–14:45 **Oral Presentation** (Simulation and Gaming for Planning and Policy 3)
Experiential Learning Through New District Asymmetric Simulation Game: Results of a Dozen of Game Play Sessions
Becu, Nicolas (CNRS, UMR LIENSs 7266, France)
Latune, Julie (AgroParisTech, UMR ESE 8079, France)
Frascaria-Lacoste, Nathalie (AgroParisTech, UMR ESE 8079, France)
A Feasibility Study of Land Readjustment Projects in Afghanistan by Developing and Applying Gaming Simulation
Sadiq, Ahmad Ramin (Nagoya Institute of Technology, Japan)
Kaneda, Toshiyuki (Nagoya Institute of Technology, Japan)
Between Game and Reality: Using Serious Games to Analyze Complex Interaction Processes in Air Traffic Management
Freese, Maria (German Aerospace Center, Germany)
Drees, Sebastian (HTW Berlin – University of Applied Science, Germany)
Meinecke, Malte (OSTIA-Spiele GbR, Germany)

13:15–14:45 **Oral Presentation** (Simulation and Gaming for Business, Marketing, and Organizational Behavior 2)
An Experiment: An International Comparison of the Decision-Making Process Using a Business Game
Iwai, Chiaki (Aoyama Gakuin University, Japan)
Morita, Mitsuru (Aoyama Gakuin University, Japan)
Development of Gaming Material and Design Framework for Integrating Entrepreneurship Education into Problem-Based Learning in Mathematics
Numazaki, Kohei (Tokyo Institute of Technology, Japan)
Matsuda, Toshiki (Tokyo Institute of Technology, Japan)
Measurement and Modeling of Proactive Exploration Behavior by Using a Virtual Space Experiment System
Suzuki, Tatsuto (Nagoya Institute of Technology, Japan)
Okamoto, Kohei (Nagoya Institute of Technology, Japan)
Kaneda, Toshiyuki (Nagoya Institute of Technology, Japan)
Tamada, Masaki (Kozo Keikaku Engineering Co., Ltd, Japan)

13:15–14:45 **Oral Presentation** (Hybrid Simulation and Gaming)
A Hybrid Gaming of Stock Investment - To Evaluate Achievement and Stock Price of Virtual Companies
Lee, Hao (Shizuoka University, Japan)
An Analysis Framework on User Experience in Simulation and Gaming Designs as Part of Hybridizing Evolution
Jakubowski, Michał (Kozminski University, Poland)
Titton, Luiz Antonio (University of São Paulo, Brazil)
Gaming Simulation Hybrids in Railway Innovation Processes
van den Hoogen, Jop (Delft University of Technology, the Netherlands); Meijer, Sebastiaan Arno (Delft University of Technology, the Netherlands and KTH Royal Institute of Technology, Sweden)

15:15–16:15 **Workshop WS 4.5.6**

16:30–18:30 **Workshop WL 5.6.7.8**

July 20
9:00–10:00 **Keynote 4**
Urban Planning Games and Simulations: From Board Games to Artificial Environments
Stephens, Richard (International Society of City and Regional Planners, USA)

10:30–12:00 **Oral Presentation** (Simulation and Gaming for Education 4)
Comparing Live-Action and Computer-Mediated Educational Games for Engineering Studies
Fedoseev, Alexey (Moscow State University of Mechanical Engineering, Russian Federation)
Understanding the History of International Politics: A Retrospective and Repeated Type of Gaming and Simulation in the Classroom
Tamai, Masataka (Ritsumeikan University, Japan)
Miyawaki, Noboru (Ritsumeikan University, Japan)
Kondo, Atsushi (Ritsumeikan University, Japan)
Preparation Activities for School Principals to ASEAN Community of M.Ed. in Educational Administration Students, the Graduate School, Thonburi University
Indrangkura Na Ayudthya Pathomporn (Thonburi University, Thailand)
Yamchuti, Nophawan (Thonburi University, Thailand)

10:30–12:00 **Oral Presentation** (Simulation and Gaming for Business, Marketing, and Organizational Behavior 3)
Implementation Model for the Gamification of Business Processes: A Study from the Field of Material Handling
Klevers, Markus (University of Technology, Munich, Germany)
Sailer, Michael (Ludwig Maximilian University of Munich, Germany)
Günthner, Willibald A. (University of Technology, Munich, Germany)
Experiential Artifact for Cross-Cultural Learning in Business Games: First Results

Titton, Luiz Antonio (University of São Paulo, Brazil)
Oliveira Neto (University of São Paulo, Brazil)
Jose Dutra (University of São Paulo, Brazil)

A Customer Preference-Based Hotel Selection Model and Its Application in Management Strategy Support

Xue, Jiao (Tokyo Institute of Technology, Japan)
Chang, Shuang (Tokyo Institute of Technology, Japan)
Ichikawa, Manabu (National Institute of Public Health, Japan)
Deguchi, Hiroshi (Tokyo Institute of Technology, Japan)

12:00–13:45 **Poster Presentation (Contents Are Cited in the End of This Appendix)**

13:45–14:45 **Oral Presentation** (Simulation and Gaming for Education 5)

A Study on Effects of "Fundamental Competencies for Working Persons" on Understanding Conservation of Historic Cities through Problem-Based Learning

Sakai, Kohei (Ritsumeikan University, Japan)
Honda, Ayaka (Ritsumeikan University, Japan)
Toyoda, Yusuke (Ritsumeikan University, Japan)
Kanegae, Hidehiko (Ritsumeikan University, Japan)

Bending time – Using Simulation to Warp Perceptions of Time for Learning Purposes

Leigh, Elyssebeth Ellen (University of Wollongong, Australia)

13:45–14:45 **Oral Presentation** (Simulation and Gaming for Planning and Policy 4)

Development of SASKE-NABLE: A Simulation Game Utilizing Lessons from the Great East Japan Earthquake

Otsuki, Satoshi (Kochi University, Japan)
Amano, Kazuhiko (Fukushima Future Center for Regional Revitalization, Fukushima University, Japan)
Harada, Makoto (CIA, Co., Ltd, Japan)
Kitamura, Ikumi (Fukushima Future Center for Regional Revitalization, Fukushima University, Japan)
Re, Jintetsu (Niigata Disaster Relief Volunteer Network, Japan)
Sadaike, Yuki (The Center for Integrated Disaster Information Research, The University of Tokyo, Japan)
Mimura, Satoru (Fukushima Future Center for Regional Revitalization, Fukushima University, Japan)

A Golf Course Design Based on Swing Select Simulation and Players' Impression Analysis

Nonaka, Tomomi (Aoyama Gakuin University, Japan)
Kubo, Hiroki (Aoyama Gakuin University, Japan)
Nishimura, Naomichi (Aoyama Gakuin University, Japan)
Mizuyama, Hajime (Aoyama Gakuin University, Japan)

13:45–14:45 **Oral Presentation** (Simulation and Gaming for Literacy)
Quest: How Inclusive eLearning Game Design Can Be Better For All
Mallon, Adrian CJF (Adrian Mallon Multimedia, UK)
Simulation and Gaming in Virtual Language Learning Literacy
García-Carbonell, Amparo (Polytechnic University of Valencia, Spain)
MacDonald, Penny (Polytechnic University of Valencia, Spain)
Perez-Sabater, Carmen (Polytechnic University of Valencia, Spain)
Montero-Fleta, Begoña (Polytechnic University of Valencia, Spain)

15:15–16:15 **Workshop WS 7.8.9**

16:30–17:00 **Awards and Celebration**

17:00–18:30 **ISAGA General Members Meeting Part 2**

19:00–21:00 **ISAGA/JASAG 2015 Farewell Buffet Party** (with the compliments of ISAGA/JASAG), at Kyoto Tower Terrace

July 21
9:00–10:00 **Keynote 5**
Sustainability and Scalability in Japanese Creative Services
Hara, Yoshinori (Kyoto University, Japan)

10:30–11:30 **ISAGA 2015 Presentation Closing Remarks**

12:30–17:00 **Social Program** (ZEN or Manga Museum and Kamishichiken)

17:30–18:30 **Social Program** (Option)

Contents of Poster Presentation
Understanding User Behavior in Information System Using Petri Nets
Li, Shing-Han (National Taipei University of Business, Taiwan, Republic of China); Chen, Wei-Yu (Chinese Culture University, Taiwan, Republic of China); Hu, Chung-Chiang (Tatung University, Taiwan, Republic of China)
Redevelopment of the Digital Game to Learn Science: High-Performance Computing Should Be Applied to the Development
Kawakami Shinnosuke (Kinki University, Technical College, Japan)
Communication Games for Activating Citizenship Education in Japan
Masahiro, Ohyama (Kobe University, Japan); Hiroki, Baba (Kobe University, Japan); Jun, Yoshinaga (Kobe University, Japan)
Participants' Perceptions of Gaming Simulation
Nakamura, Mieko (Ryutsu Keizai University, Japan)
GRID: Simulation Game About Risk and Process Management
Treske, Eric (Intrestik Organisation & Planspiel, Germany); Schwägele, Sebastian (ZMS, Duale Hochschule Baden-Württemberg Stuttgart, Germany)
The Design of Lifestyle-Related Disease Game and Its Practice for Regional Version

Hibino, Aiko (Hirosaki University, Japan); Ema, Arisa (The University of Tokyo); Ueda, Akifumi (Citizen Science Initiative Japan); Hishiyama, Reiko (Waseda University)

Combining Gaming, Simulation, and Disaster Dialysis Medicine – Development of a Tabletop Disaster Preparedness Exercise Game

Nakatsuka, Mineo (Japanese Red Cross Medical Center, Japan)

Environmental Education by Playing an Industrial Waste Game: A Comparison Between Chinese, Korean, and Japanese University Students

Maeda, Hiroe (Nanzan University, Japan); Hirose, Yukio (Kansai University, Japan); Ohana, Kyosuke (Kyoto University, Japan)

Fab Safe – Preparing Fab Labs and Maker Spaces for Occupational Health and Safety

van der Hijden, Pieter (Sofos Consultancy, the Netherlands); Bansal, Lipika (Pollinize, the Netherlands)

A Business Game as an Educational Tool for Learning About Information Security Management

Sasaki, Nobusuke (Prefectural University of Hiroshima, Japan)

A Prototype of Community Cooperation Game: A Simulation Game of Community-Based Flood Disaster Management

Puntita, Tanwattana (Chulalongkorn University, Thailand); Toyoda, Yusuke (Ritsumeikan University, Japan)

Harvest and Interest – A Game to Facilitate Understanding of Michael Ende's Momo

Kobayashi, Shigeto; Azuma, Shinpei (Japan Advanced Institute of Science and Technology, Japan); Sugimoto, Shohei (Japan Advanced Institute of Science and Technology, Japan); Masumi, Akira (Japan Advanced Institute of Science and Technology, Japan)

Community Currency Game: Results and the Next Challenge

Yoshida, Masayuki (Joetsu University of Education, Japan); Kobayashi, Shigeto (Japan Advanced Institute of Science and Technology, Japan)

Learning Game in the IT Service Industry Considering Players' Values

Goto, Yusuke (Iwate Prefectural University, Japan); Sasaki, Kohei (Iwate Prefectural University, Japan); Minamino, Kenichi (Iwate Prefectural University, Japan); Watanabe, Yoshikazu (Iwate Prefectural University, Japan)

Comparing the Effectiveness of Simulation Game with Common Activity-Based Teaching in Environmental Education: A Case Study in an Undergraduate Waste Management Program in Hong Kong

Yeung, Siu Kit (The Hong Kong Institute of Education, Hong Kong SAR, China

Rediscovering "School-Commuting Roads" – A Gaming Design for the Development of Elementary School Children's Place Attachment on Their Local Community

Chiwata, Maho (Nagoya University of Foreign Studies, Japan); Takahashi, Risa (Nagoya University of Foreign Studies, Japan); Ogura, Hiroko (Nagoya University of Foreign Studies, Japan); Takai, Mari (Nagoya University of Foreign

Studies, Japan); Zaito, Llerena (Nagoya University of Foreign Studies, Japan); Shirotsuki, Masahiro (Nagoya University of Foreign Studies, Japan)

A Gaming Simulation of Conflict Resolution for an Economically Stratified Society Using Daifugo

Sugiura, Junkichi (Keio University, Japan)

Developing "Iitokosagashi" Communication Game for Adults with Developmental Disorders

Ando, Kaori (Nara Women's University, Japan); Jo, Kanchi (Iitokosagashi, Japan); Sachiko, Hara (LINK, Japan); Adachi, Nahoko (Osaka City University, Japan)

A Study of Wisdom of Crowds Model for Game System

Okano, Tadashi (Ritsumeikan University, Japan)

Condition Survey on Game Play of Undergraduate Computer Science Students

Ohashi, Yutaro (Nippon Institute of Technology, Japan)

Feelings of Superiority and Inferiority and Social Identity by the Members of Predominance and Inferior Groups

Taresawa, Yumiko (Konan Women's University, Japan)

Appendix B: Committee Members

Organizing Committee (Program Committee)
Hidehiko Kanegae (Chair), Ritsumeikan University, Japan
Yusuke Arai, Kyoto University, Japan
Hiroshi Deguchi, Tokyo Institute of Technology, Japan
Yoichi Erikawa, Foundation for the Fusion of Science and Technology, Japan
Yukio Hirose, Kansai University, Japan
Manabu Ichikawa, National Institute of Public Health, Japan
Toshiyuki Kaneda, Nagoya Institute of Technology, Japan
Toshiko Kikkawa, Keio University, Japan
Shinobu Kitani, Tohoku University, Japan
Hiroyuki Matsui, Kyoto University, Japan
Motonari Tanabu, Yokohama National University, Japan
Yusuke Toyoda, Ritsumeikan University, Japan

Scientific Committee
Motonari Tanabu (Chair), Yokohama National University, Japan
Toshiko Kikkawa (Vice-Chair), Keio University, Japan
Yusuke Arai, Kyoto University, Japan
Geertje Bekebrede, Delft University of Technology, the Netherlands
Yukio Hirose, Kansai University, Japan
Arata Ichikawa, Ryutsu Keizai University, Japan
Manabu Ichikawa, National Institute of Public Health, Japan
Chiaki Iwai, Aoyama Gakuin University, Japan

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