Using games as learning tools for managing sustainable urban development processes

A case study based on the development of the North Harbour, Copenhagen

Eszter Juhasz-Nagy
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Aalborg University
Development and Planning
Skibbrogade 5
9000 Aalborg

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Supervisors: Patrick Driscoll
Enza Lissandrello

Author:

_____

Eszter Juhasz-Nagy

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Abstract

This research investigates the possibility of using serious games as a means to help prepare planning students for dealing with the task of negotiating sustainable urban development processes, specifically to aid their cognitive learning in relation to the social and economic goals of stakeholders of such processes. Preparing future planners for this task is important, as these various aspects of sustainable development are interrelated: while there are inherent conflicts between them, there are also synergies, and it is not possible to disregard either social equity or economic growth if a well-balanced outcome is expected from an urban development process. Planning education makes use of various experiential learning tools, such as problem-based learning, to prepare planners for dealing with the poorly structured, messy processes in planning practice. Games as experiential tools have also been used in planning for decades, providing an aid for learning, practice and research. It is possible that using games can be beneficial, combining skill development and cognitive learning. Therefore, this research attempts to find the answer to the question:

How does a game affect the cognitive learning of planning students in relation to achieving different, often conflicting social and economic goals of stakeholders in a sustainable urban development process?

In order to answer this question, an exemplifying case study was conducted by creating a game about a sustainable urban development process in the North Harbour in Copenhagen, and was played by planning students at Aalborg University, whose learning was evaluated. In preparation to the case study, the state of research was reviewed in the fields of sustainable urban developments, game-based learning and the design of serious games. The game was created in collaboration with a group of Medialogy students at Aalborg University Copenhagen, and it is a competitive strategy game with role-playing and puzzle elements. It was based on the social and economic goals of the main stakeholders in the development process: the City of Copenhagen and the Danish State, CPH City and Port Development, and the various investors and developers involved in the area.

Based on the case study and the review of the state of the art, the research concludes that games can be useful for the purpose of facilitating cognitive learning. The verbal knowledge or students increased during gameplay, and they showed signs of learning. Their interactions about the goals and strategies changed during the sessions, and this reflected increased knowledge as well. Based on the results, it is not entirely clear whether games are useful for increasing the cognitive strategies of students about the goals in sustainable urban development processes, but introducing the students to the rules in a written format prior to gameplay seems to affect this aspect positively.

The researcher proposes further areas of investigation as well, such as comparative studies between digital and board games as well as single- and multiplayer games in relation to their ability to encourage reflective, interactive behaviour about the learning goals; and the effect of previous familiarization of players with the rules on the changes in their cognitive strategies.

Preface

This report documents a two-semester research project into the use of games as cognitive learning tools in relation to sustainable urban development, and serves as a master thesis at the Urban Planning and Management programme at Aalborg University. It is intended primarily for use within the University, but it can also be relevant for educational institutions and planning organizations interested in utilizing game-based learning for improving the knowledge and management skills of planners in sustainable urban development processes.

The game created as part of this project was designed in collaboration with Medialogy master students Nicholas Egede Bukdahl, Mindaugas Augustas Pronckus, Dennis Godtfredsen and Simonas Garbaciauskas.

I would like to thank Patrick Driscoll for his support and supervision; Silvia Dragomir, whose work on a similar game has inspired this project; and Hendrik Purwins and Henrik Schønau Fog, without whom the collaboration with the Medialogy students would not have been possible. I would also like to thank Rita Justesen from CPH City and Port Development for devoting her time not only to providing information in relation to the North Harbour development and the work of her organization, but also to testing the game and giving feedback on it together with her co-workers. Finally, I would like to thank the participants of the workshops for their time.

All translations from Danish to English were made by the author.

Figures, tables and images are numbered continuously within each chapter. Recurring figures are numbered according to their first appearance.

The reference system in the report is based on the Harvard method.

Some of the appendices are only available on the CD attached to this report. The appendices most relevant for understanding the research project and the analysis are included in the printed version.

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1 Introduction

Planning practice has to deal with complex situations where values, needs and goals of different stakeholders have to be balanced all the time. Rittel and Webber's classic article, *Dilemmas in a General Theory of Planning* (1973) emphasizes the pluralism of society and thus the commonplace existence of *wicked problems* in the public sphere and planning. Sustainable urban development is no exception from this trend. Balancing the different aspects of sustainability can be seen as such a complex situation, where social, economic, and environmental goals and limitations have an interwoven impact on the end results (Campbell 1996), particularly when considered together with the social and political backdrop of the development process and thus the pluralism of stakeholders and their goals (Wallbaum et al. 2011). It is important that planning professionals and students are provided with means that facilitate learning about such situations and the complex trade-offs that are involved (Campbell 1996). According to research in the field, games can be used as such tools.

The three-fold view on sustainable development originates from the 1987 report of the Brundtland Commission (World Commission on Environment and Development 1987), in which the global balance of economic growth, social equity and ecological concerns are named as central for achieving a sustainable future. However, inherent conflicts are present between each of these aspects (Campbell 1996) – both on the conceptual level and in the specific goals of various stakeholders.

The conflict between social equity and economic growth, also known as the *property contradiction* (Foglesong 2003) is one that, while definitely a conflict that belongs under the umbrella of sustainable development, have been a concern of urban planning since before sustainable development began to shape the agenda. The conflict of social and economic needs were considered central in the literature on capitalism in the 1970's: both sides of it are considered a necessity in a capitalist society, and therefore continuously balancing the two is unavoidable. Furthermore, synergies between the two also exist if the balance is achieved. While the focus of research and discussion today is shifting towards the ecological concerns, understanding and being able to deal with ensuring economic growth and social equity in planning processes is just as important for achieving a balanced outcome in sustainable urban development. Future planners need to understand this conflict and be able to facilitate a negotiation process between the various stakeholders in a way that can lead to mutually beneficial solutions (Campbell 1996; Wallbaum et al. 2011). Therefore, planning education needs tools that can facilitate learning both in terms of the concepts and goals involved, and in terms of skills of conflict resolution.

1.1 Problem formulation

It is likely that experiential learning can serve this purpose, by shifting the focus from the strictly theoretical discussions to solution-oriented approaches for problem solving, through methods such as problem- or project-based learning (Bertolini et al. 2012) or simulation games based on reality. The use of experiential learning is considered a valuable approach in many fields, among them in planning education, as it provides students with knowledge and skills that are readily useful in practice. Games, or in other words simulation exercises, are used in educating trainees in conflict resolution (Meerts 2009), as they provide valuable training in the necessary skills by allowing practice in simulated situations. For similar reasons, games have been used in planning practice and education since after World War II (Mayer 2009; Duke & Geurts 2004). They are seen as useful tools for facilitating

experiential learning, which is an important approach in educating future planners, since it helps them acquire practical skills that will be useful in their professional lives. Games are claimed to be especially useful in modelling complex, multi-stakeholder situations (Mayer 2009), which, as discussed, are commonplace in planning practice. Furthermore, they provide a "safe space" for experimentation (Geurts et al. 2007), which supports the learning of the participants in relation to these situations without causing long-term consequences in the real world.

However, there are arguments that the exact benefits of game-based learning are not sufficiently founded in scientifically sound, systematic research. Therefore, there is an outstanding need for systematic assessment and evaluation of the learning that happens with the aid of games (Gosen & Washbush 2004). In recent years, there has been some research in the field, and systematic tools are gradually developed and validated for the assessment of game-based learning (see Mayer et al. 2014). There is an effort to develop best practice for research in order to fully understand what games can and cannot be used for and what personal, social or other background characteristics influence game-based learning (see Mayer et al. 2014).

The literature provides a long list of learning outcomes that games support and facilitate (such as negotiation skills), but many gaps exist in terms of research supporting these claims. Returning to the problem of learning about dealing with the conflict between social and economic aspects in sustainable urban development, two distinct areas can be identified: the skillset necessary for facilitating conflict resolution, and the cognitive knowledge and understanding of the concepts at hand and their interrelations. While games and simulations are used for the training of skills in many various fields (Harteveld 2011), and specifically in the field of conflict resolution as well, the usefulness of game-based learning in relation to cognitive learning, and specifically of high-level cognitive understanding is more debated. Researchers warn that games are not inherently reflective environments, which causes difficulties in the process of high-level cognitive learning (such as the creation of cognitive strategies) (Harteveld 2011). However, there is also empirical evidence that simulation exercises affect the knowledge organization of participants (Geurts et al. 2007).

As with any learning tool, it is vital to understand the requirements that serious games have to fulfil in order to serve their purpose (Harteveld 2011). The design of the game has a fundamental influence on its usefulness as a learning tool. Such games are typically created for the specific context and about the specific problem. The design considerations have to serve the purpose of the game in various areas: in relation to the reality of the problem, to the nature of the game as a learning tool, and to the nature of the tool as game as well. While it is important that the game serves as a learning tool, it is just as important that it remains entertaining, in order to be a game and not become merely a simulation exercise. It is therefore important that all aspects of the design are carefully considered and balanced with each other during the process of game creation and pilot testing. The resulting game should adequately represent the development process viewed from the angle of the specific problem at hand, include mechanisms that encourage cognitive learning, and provide gameplay that is fun and inherently serves the purpose of the game as a learning tool.

Based on the abovementioned background, it seems necessary to deepen the understanding of the way games affect learning in relation to economic and social goals in sustainable urban development, especially in the area of cognitive knowledge.

1.2 Research question

Attempting to address the above explained problem, the research is guided by the following research question:

How does a game affect the cognitive learning of planning students in relation to achieving different, often conflicting social and economic goals of stakeholders in a sustainable urban development process?

The research project presented in this report aims to answer the research question by conducting an exemplifying case study focusing on the game-based cognitive learning of planning students at Aalborg University in relation to the conflicts and synergies between the social and economic goals in sustainable urban development. This is done by facilitating gameplay sessions, using a serious board game created in collaboration with a 7th semester Medialogy group at Aalborg University Copenhagen based on an on-going development process in the North Harbour district in Copenhagen.

Image 1.1 - Construction at the development site in the North Harbour, Copenhagen

The development process

The aim of the development process in the North Harbour is to create the sustainable district of the future, where the goals of the planning agencies involved are well documented. This makes it a perfect candidate for learning about the stakeholder goals in such processes. It is an ongoing process, which means that the outcomes are not clear at this point - it is not possible to tell whether the social and economic goals guiding the process are going to be successful in creating economic growth and social equity in the neighbourhood. This provides a certain sense of openness, and an opportunity for players to experiment in their attempts of reaching their goals, as no approach has been proven to be "right" or "wrong".

The game – a tool created for facilitating cognitive learning in sustainable urban development

In order to address the problem, it was necessary to create a tool that serves the purpose derived from the research question. Therefore, the game used in this project was based on the development process

at North Harbour, Copenhagen. The model of the game is based on the process of development, and the roles of the main stakeholders involved. The aim was to base the in-game goals on the goals of the stakeholders, thus ensure that the game serves its purpose in facilitating learning in relation to these goals. The resulting game is a competitive strategy game with role-playing and puzzle elements.

The site of the case study

Education at Aalborg University is focused on problem-based learning, which is an experiential learning method similarly to game-based learning. The students are therefore expected to have some level of experience with experiential learning. As the development process the game is based on is also in Denmark, it is also likely that they are familiar with the planning system and the relationships between the main stakeholders in the planning process, which can help them understand the basic premise of the game.

1.3 The main findings of the research

Based on the case study, the research presented in this report suggests that games are useful tools for facilitating cognitive learning in relation to the various socially and economically focused stakeholder goals in sustainable urban development processes, however with some limitations. The results of the case study show that playing games increases the verbal knowledge of students in relation to the various goals involved in the property conflict in sustainable urban developments. In relation to high-level cognitive learning, the picture is not as clear. The research reaffirms the claims that games do not necessarily improve the cognitive strategies of players. However, it suggests that familiarizing the players with the concepts prior to the game in the form of written material (such as the rulebook of the game) improves the outcomes in this area of learning significantly. Based on the review of literature in the fields of the research and the results of the case study, it is argued that games seem useful tools for facilitating cognitive learning in the targeted area of expertise, but this usefulness is dependent on a number of design considerations.

One of the most important ones is the game's representation of reality. It is vital to ensure that the relevant aspects of the development process, such as the stakeholders and their goals, relationships, etc. are adequately modelled, in order to ensure that the players do not receive incorrect information from the game. Changes made in the model in relation to reality have to be pointed out, and a discussion or debriefing after the gameplay session is a good platform for this.

The research also provides interesting insights about the game design considerations, which disagree with the position expressed in the reviewed literature. During gameplay, students exhibited interactive and reflective behaviour, without being specifically prompted to do so. As the literature claims that games are not inherently useful in facilitating such behaviour, it is unclear what caused this discrepancy. It is possible that the reason lies in the differences between digital and board games, or single- and multiplayer games. Another possible explanation is that the site of the case study affected the behaviour of students: as they are accustomed to experiential learning environments, it is possible that they engage in reflective behaviour naturally without being specifically prompted to do so.

1.4 Structure of the report

The report presents the research project according to the following structure:

Introduction	•The difficulties of undertstanding and handling the different social and economic goals of stakeholders in sustainable urban development processes •**Problem formulation:** Accepting that games are useful tools for skill development in process negotiation, it would be interesing to understand their use in facilitating cognitive learning in the targeted topic as well. •Research question and the case
State of the art	•Sustainable urban development, the property conflict and the necessity of preparing planners for dealing with it •Game-based learning: an experiential approach to learning. Cognitive learning. Evaluating game-based learning •Making serious games
Methodology	•**Research design:** pragmatism and its effect on the research; the design of the exemplifiying case study; proposition and proposed patterns; analytical approach; creating the game; workshops •Data collection protocol •Significance of the research, limitations and ethical consierations
The case	•The development process in the North Harbour: stakeholders and goals •The game •The site of the case study: Aalborg University and its urban planning programmes
Analysis and interpretation	•Changes in the verbal knowledge of participants •Signs of learning and changes in participant behaviour •Changes in the cognitive strategies of participants
Discussion	•Discussion and generalization of the findings of the case study in the light of the theoretical position of the researcher and the state of the art
Conclusions	•**Conclusions of the research**: games are useful for facilitating improvement of verbal knowledge in the area of various goals in sustainable urban development; they can also be useful for improving cognitive strategies if properly introduced. •Recommendations for further research: Investigating the affect of prior familiarization with the subject matter (in written format) on improving cognitive strategies; comparing boad games and digital games/single and multiplayer games in improving cognitive strategies.
Reflections	

Figure 1.1 - The structure of this report

2 State of the art

The conflict between the economic and social aspects of urban development is one that planners and researchers have been aware of since before sustainable development became central on the agenda. Campbell, in his article on the main conflicts between the three aspects of sustainable development (Campbell 1996) recalls this concept and emphasises the importance of understanding and accepting the contradictions that exist between the economic, environmental and social aspects of sustainability. In his view, it is the planners' task to understand these conflicts and attempt to manage and resolve them through various approaches, which include providing a clear vision and negotiating the process. This suggests that it is important to prepare planning students for conflict resolution: to provide them with the necessary knowledge about the issues and conflicts within sustainable urban development as well as with practical skills they can use in processes of conflict negotiation and resolution.

The training and educational methods utilized in conflict resolution make use of simulation exercises and role plays as tools to prepare negotiators for handling real-life problems and crises (Meerts 2009). They make use of simulation exercises for the valuable practice and skills they provide. There is a significant body of literature originating from the last 45 years that argues that games and game-based learning are useful tools that make use of experiential and, in case of multi-player board games, social approaches to learning and teaching. Games provide a situated environment that encourages experimentation. These characteristics make games especially useful in urban planning education. With proper guidance, games can promote a reflective process, which enables high-level cognitive learning. Therefore, games and simulation exercises appear to be useful tools to be utilized in planning education, helping students to deal with negotiating and resolving the inherent conflicts in sustainable urban development. This line of argument leaves one question open, however: are they also useful for learning about these inherent conflicts within, and about the interests and goals of the various stakeholders related to the different aspects of sustainability?

It is important that the evaluation of this cognitive learning be done in a well-structured, scientifically sound way, as regardless of the many assumptions and claims that exist in this growing field, there is still need for more extensive, systematic research into the effectiveness of game-based learning.

However, before one can evaluate the way games affect cognitive learning in relation to a specific area of knowledge, one has to make sure that the game used in the study is designed in a way that makes it capable of facilitating this type of learning on the topic in question. The purpose, goal, structure, mechanics and parts of the game are all factors that determine whether it is useful as a learning tool or not: whether the players are able to gain cognitive knowledge in the desired areas, and whether the knowledge they gain transfers into useful knowledge in practice.

In order to gain a more clarified understanding of the problem, the theoretical framework for this research is comprised of three distinct, yet interrelated areas: planning, serious games, and learning. The research is interested in the intersection of the three fields. The framework can be illustrated with the following figure:

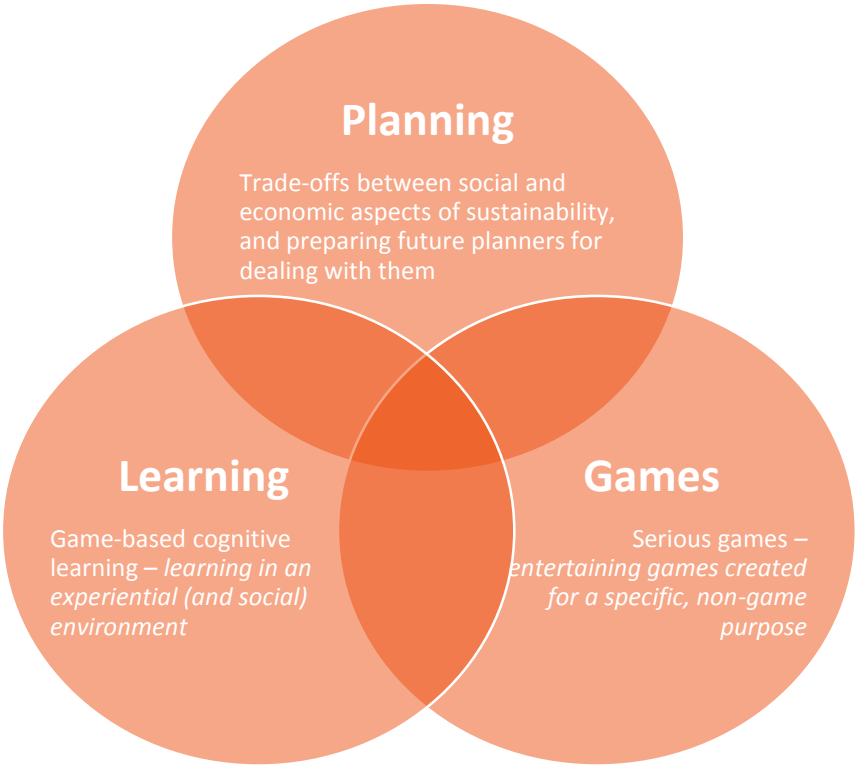

Figure 2.1 - The theoretical framework of the research

This chapter presents past and current research into the three areas of the theoretical framework and their intersections. Its purpose is to explore the relationship between social and economic goals in sustainable urban planning, the place of serious games in urban planning and planning education, and the design of the games that are used for such purposes as well as the methods for the assessment of game-based learning. For this purpose, the triangular concept of sustainability is explained with specific focus on the social and economic aspects and their conflict. Afterwards, the idea and origins of serious games are introduced, and the history of planning games are explored, followed by a focus on more contemporary research, especially on non-digital games. After exploring the rationale for using serious games in planning, the chapter moves on to investigate the different methods that are used for evaluating the learning that happens through games, and present some of the findings about game-based learning. Finally, a practical approach to making serious games developed by Casper Harteveld (2011) is presented.

2.1 Economic and social goals in sustainable urban development

Sustainability is one of the focal topics in today's discussions in many fields, among them urban planning and urban development. The changing climate, economic crises, the ever-growing differences between the rich and the poor leads researchers and professionals globally to attempt to find solutions that can lead to a more sustainable future – environmentally, economically, and socially. The Brundtland Commission's report from 1987 defines sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" (World Commission on Environment and Development 1987, p.41).

2.1.1 The three aspects of sustainability, and the property conflict

Based on the work of the Commission arises the three-fold concept of sustainability: economic growth, social equity and environmental sustainability. The concept can be illustrated with the help of the following figure:

Figure 2.2 - The triangle of conflicting goals in sustainable development (based on Campbell 1996)

As the figure shows, there is inherent conflict between each of the three aspects of sustainability, which makes planning and executing sustainable development a difficult task (Campbell 1996). As the focus of this research is on the social and economic aspects, those received more emphasis in the visual representation as well.

While the increasing number of natural disasters and other signs of climate change led to a focus on the environmental aspect of sustainability, it is still important to address the other two aspects if sustainable urban development is to be achieved. Indeed, Wallbaum et al. (2011) argue that even today, these aspects are the most important from the municipal point of view. Social equity and economic growth, as well as the conflict between them, has been a topic in urban planning since before sustainability got on the agenda. The term *property contradiction* was coined by Foglesong in his definitive work *Planning the Capitalist City* (Foglesong 2003) to describe the main issue between the social and economic needs in urban planning within a predominantly capitalist context. In his view, the main issue is between the private ownership of land and its inherently social nature. Foglesong (2003) describes urban planning as an expression of the social, collective nature of the land, where the state intervenes in its distribution, often against the will and needs of the market. It is necessary that the state intervene in market processes regarding land distribution, in order to ensure that collective needs are fulfilled – and therein lies the key point of this conflict. Without society thriving, the market cannot survive and just land distribution through urban planning is a requirement for the well-being of society. However, just

distribution of the land often hurts the interest of the market; and finally, a well-functioning market is necessary for the well-being of society (Foglesong 2003).

2.1.2 Dealing with the property conflict

While this argument stems from a strict capitalist view on land, market and society, it did not lose its relevance today. Campbell (1996) extends this argument and includes other conflicts in relation to claims in property: management and labour, landlords and tenants, as well as long-time and new residents. While parts of the conflict between the various aspects of sustainability might stem from misunderstandings between proponents (Campbell 1996), nevertheless, it is not possible to reconcile or resolve the conflicts without an in-depth understanding of the issue, and strategies to overcome misunderstandings and conflicting goals between stakeholders in sustainable urban development processes (Campbell 1996; Wallbaum et al. 2011). It is also important to realize that beside the conflicts, there is potential for synergy between the social and economic aspects and goals in urban development: for example the potential for trickle-down benefits from overall economic growth to all segments of society (Campbell 1996). Therefore, it is important to find solutions that are mutually beneficial for those involved through methods of negotiation or conflict resolution – coordinated by the urban planners.

Campbell (1996) emphasises the importance of planners managing and resolving the conflicts inherent to sustainability in order to achieve positive outcomes in urban development processes, while promoting a clear vision of sustainability. He proposes two main ways to do this: conflict negotiation, and redefining the language. Both involve accepting and including all points of view in the planning process, in order to achieve a balance of the various stakeholder goals and the three segments of sustainable development, which is capable of promoting the synergies and minimizing the conflicts between these segments and goals (Campbell 1996). However, this is only possible if planners are knowledgeable about these goals – some of which are universal but some of which are specific to the planning problem at hand – and have the skills to manage the negotiation process. Therefore, planning education needs tools that can prepare planners for dealing with these situations both skilfully and with ready knowledge that is applicable in the messy reality of urban planning processes.

2.1.3 Educating planners

Experiential learning approaches are capable of providing these outcomes. The importance of these approaches in planning education today is discussed in the literature, and the usefulness of problem- and project-oriented learning in this context is often cited. These learning methods prepare students for dealing with the messy problems in planning better than the world of academia, as they require students to figure out approaches to solving real-life problems (Bertolini et al. 2012). It makes it possible for students to analyse and understand power-relations and struggles more than traditional, lecture and research based education can. However, while problem-oriented learning can provide important insights about real-world planning situations (Balassiano 2011; Shepherd & Cosgrif 1998; Wu & Brooks 2012), it does not carry the same benefits as game-based learning when it comes to the acquisition of negotiation and conflict-resolution skills.

Game-based learning has a well-established background in educating and preparing trainees for conflict-resolution (Meerts 2009). The field is well-researched as well as tried and tested. As the set of

skills propagated in this field is similar to those required by planners when dealing with conflicting goals in sustainable urban development processes, the usefulness of games in this field seems self-explanatory. The usefulness of games in relation to skill acquisition and refinement is generally accepted in the field of planning also, as it is shown in a later part of this chapter.

It seems that while problem-based learning seems more beneficial for learning how to understand messy, real-life problems, games are more useful for skill development – both of which are necessary for planners in attempting to manage sustainable urban development processes. It seems that it would be beneficial for the field of planning education if one of these tools would prove useful for both aspects: if, for example, game-based learning would prove beneficial in the realm of cognitive learning as well as skill acquisition. In order to understand the whether this is possible, the following sections explore the area of learning, serious games, and game-based learning in more detail, especially in the field of urban planning.

2.2 Game-based learning and its evaluation

As the previous sections established, experiential learning is a useful approach in planning education, as it provides opportunity for situated learning, and enhances the acquisition of skills and knowledge necessary for dealing with conflicts and problems in sustainable urban development processes. The following sections outline the main concepts of learning, with specific focus on game-based learning as an experiential learning approach, and the evaluation of its effects. In order to introduce game-based learning, the concept and history of the use of serious games is introduced, focusing on the field of planning.

In this report, the term *serious games* is used in the broad sense that is provided by Abt (1970), who defines them as games that are used for a purpose and are entertaining. The term is chosen for its simplicity of expressiveness in referring to the phenomenon. However, the understanding of the term is combined with simulation games as defined by Mayer (2009) (see below). This, very concisely, means that serious games are understood in this report as entertaining, interactive environments, where players learn by taking actions and receiving feedback from built-in mechanisms. In relation to learning facilitated by the use of serious games, the term *game-based learning* is adopted from Mayer (2014) for simplicity of expression.

Before turning the focus to game-based learning, it is worth exploring the concept of learning, with a focus on experiential and cognitive learning.

2.2.1 Learning

Learning is a wide field and there are many different approaches to understanding it. A thorough understanding of learning makes it easier to create and evaluate a game that is aimed at facilitating learning (Wilson et al. 2008). Literature on pedagogy and psychology as well as on policy processes and planning etc. offers a number of ways to categorize learning (e.g. Bloom et al. 1956; Kolb 1984). This categorization can be based for example on the way learning happens (Harteveld 2011) – in an experience-based or social context for example, or on what the outcomes of learning are.

In this report, the focus is on experiential learning, as it is an important approach in planning education and the one most commonly cited in relation to game-based learning. The focus is furthermore on

cognitive learning outcomes, as the effect of games on these outcomes is not very commonly investigated, and it is interesting in relation to learning about the conflicting social and economic aspects of sustainable urban developments.

How?

While the focus of the report is on experiential learning, it is worth to introduce the other influential approaches to learning briefly as well. The main theories (or paradigms) about the way learning occurs identified by Smith (1999; in Wu et al. 2011) are *behaviourism, cognitivism, humanism,* and *constructivism*. For behaviourists, learning results in an observable change of behaviour and is a product of stimulation and reinforcement (Thorndike 1999). Cognitivists on the other hand argue that learning involves thinking. According to cognitivists, such as Anderson (1982), prior knowledge plays an important role in learning (Harteveld 2011; Wu et al. 2011). They emphasize the active role of the learner in the learning process through interpretation of sensations rather than passive reception of knowledge (Anderson 1982). The humanist paradigm (Rogers 1983) turns its attention even more towards the learner and places it in the centre of the learning as opposed to cognitivism, where the main focus is on the acquisition of knowledge (Harteveld 2011; Wu et al. 2011). Finally, constructivism, including the work of Piaget (1999) and Kolb (1984), holds that learners construct their knowledge by interpreting information and reconciling it with their previous knowledge (Harteveld 2011). This means that culture, background and motivation play an important role in the learning process. A consequence of this is that knowledge is subjective and highly dependent on the individual (Resnick 1987; in Wu et al. 2011).

Out of the numerous theories explaining how learning occurs, the most typically cited ones for game-based learning are related to experience-based or experiential learning, and social learning (Harteveld et al. 2010, Harteveld 2011, Haug et al. 2011., Mayer 2009). Since this research has a focus on the individual's learning as opposed to the group, experiential learning is considered the most relevant theory on how learning occurs in this context.

It is often stated that games facilitate experiential learning (e.g. Geurts et al. 2007; Harteveld 2011). As Harteveld states, "*games are "experiential" by nature*" (2011, p.154). Experiential learning shows a definitive departure from the traditional, lecture-based teaching and learning approach towards a learner-centered approach. Experiential learning was defined and described in detail by Kolb (1984), but references to *experience-based learning* can also be found in literature, and the two expressions are often used interchangeably. In experiential learning, the learner has an active role in acquiring knowledge (Kolb 1984) instead of the passive receiver role commonly adapted in more traditional approaches. It is modelled as a cyclical process that comprises active experimentation, concrete experience, reflective observation, and abstract concepts, and that transforms experience into knowledge (Kolb 1984). This theory can be considered as belonging to the constructivist paradigm as it emphasizes the role of the learner in constructing his or her knowledge through reflection about experiences (Harteveld 2011); or to the humanist paradigm, as it places the human being into the centre of their own learning process, with the teacher acting as a facilitator (Wu et al. 2011).

What?

Whichever of the above theories one accepts about learning, it is possible further to categorize learning based on the outcomes of the learning. A commonly used theory here is Bloom's taxonomy of

educational objectives (Bloom et al. 1956). Bloom defines three categories or domains of learning: the *cognitive,* the *affective* and the *psychomotor.* Another related distinction is between *cognitive, skill-based* and *affective* learning outcomes described by Kraiger, Ford and Salas (1993) based on Bloom's and Gagne's taxonomy. There are other variations, such as *knowledge, skills,* and *attitudes* (or *abilities*) (Harteveld 2011). Here *knowledge* is a subcategory of the cognitive domain, while *skill* can belong under either the cognitive or the psychomotor domain (Harteveld & Bekebrede 2011).

For this research, following the example of Wilson et al. (Wilson et al. 2008), the theory of Kraiger et al. (1993) is adapted for the categorization of learning outcomes, since it offers guidance on evaluation methods for the specific learning outcomes, is comprehensive in its theoretical basis and detailed in the defined categories and subcategories (Wilson et al. 2008). Furthermore, its comprehensive nature offers parallels to other definitions of learning outcomes apparent in the literature, which is helpful in extending the selection of evaluation methods for specific learning outcomes. According to this categorization, the most relevant category for this research is that of the cognitive learning outcomes. Kraiger et al.'s categorization can be visualised with the help of the following figure:

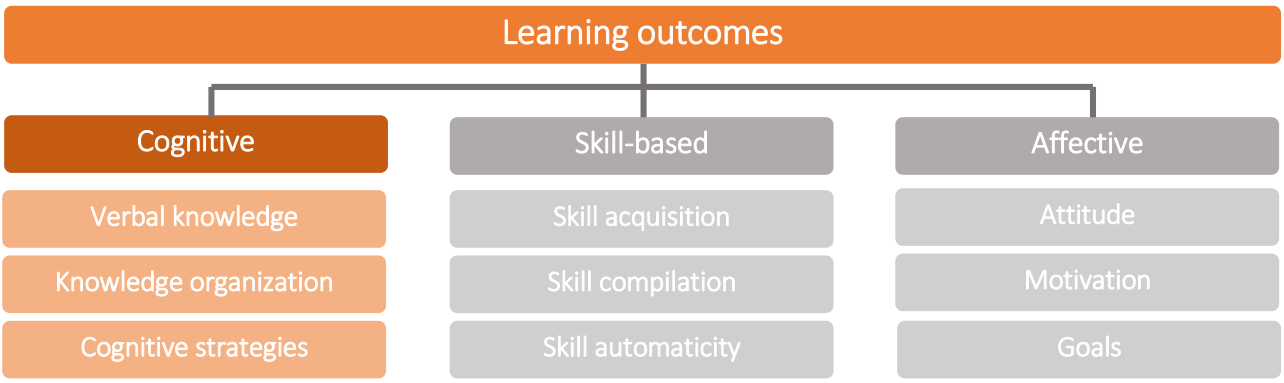

Figure 2.3 - The categorization of learning outcomes based on Kraiger et al. (1993)

In Kraiger et al.'s (1993) theory, **cognitive learning outcomes** are further divided into *verbal knowledge, knowledge organization* and *cognitive strategies.* Achieving the three levels of cognitive learning outcomes happens in sequence (Kraiger et al. 1993; Wilson et al. 2008). After verbal or declarative knowledge is gained, it needs to be organized and stored for later recall, which is done through creating additional mental models, and increasing the complexity of existing mental models (Kraiger et al. 2003; Wilson et al. 2008). These more complex models can, for example, incorporate problem definitions and strategies for solving specific problems that can contribute to an increase in the speed of knowledge recall. Then, using the learned and organized knowledge, one develops and applies cognitive strategies. Wilson et al. (2008) relates this part of the process to *application* and *evaluation* within Bloom's taxonomy , which according to them means "*use of a concept to solve new or novel problem*" and "*make judgement about information"* (Wilson et al. 2008, p.222), respectively. Other theorists, such as Anderson (1982) also follow the classification of three steps of cognitive learning, and while the names of the stages vary between the different sources, the content of the stages show a large degree of correspondence.

As this part of the chapter showed, learning is a large field, and learning can happen in different ways and have different types of outcomes. The following sections introduce serious games, starting with the

concept of games, explaining the phenomenon of serious games, and briefly reciting the history of using such games in various fields, with a specific focus on the field of planning.

2.2.2 Serious games

Games have been used for a long time for serious and non-serious purposes throughout history. The term *serious games* was coined by Abt in his 1970 book of the same title (Abt 1970; cf. Mayer 2009; Harteveld 2011) and it is now commonly used for games for non-entertainment purposes (Crookall 2011; Harteveld 2011).

Definition

Defining serious games is not straightforward, and the problem already starts with defining the concept of games. The English language offers a distinction between the noun *game* and the verb most often used in connection with it: *play* (Poplin 2012). Therefore, it seems necessary to define both. Play is defined by a number of authors in different ways, but the consent is that it is a free, open-ended activity (Huizinga 1938; in Poplin 2012) done for the pleasure of the activity itself (Piaget 1999). It serves to copy certain behaviours, but does not aim to achieve an end, such as winning (Poplin 2012). Games, on the other hand, can be viewed as formalized types of play (Harteveld 2011), in which a set of rules define the activity and there is a goal that players try to achieve. Furthermore, subgroups can be identified within the concept of games, such as games of chance (e.g. flipping coins) and games where achieving the goal require conscious effort on the side of the player. Harteveld (2011) refers to the latter as *real games* – and serious games belong to this group.

Understanding the concept of serious games is further complicated by the diverse terminology used for describing them. Different terms, such as *social impact games*, *persuasive games*, *games with a purpose* (Mayer 2009), *gaming simulations*, are used by different authors. Overall, games that are used for non-entertainment purposes are commonly referred to as simulation games, because that is what they do: they simulate a simplified reality (Eisenack 2012) of for example a planning problem (Mayer 2009; Mayer et al. 2004). The game represents a real life situation, and participants can interact with the simulated model through the game. This simulation can happen through the mechanics of a board game, which usually requires a model that is largely simplified (Eisenack 2012) or can be done by a computer, which is usually capable of running more complex simulation models (Harteveld 2011; Mayer 2009).

A definition of simulation games comes from Mayer (2009, p.825): they are

> *"experi(m)ent(i)al, rule-based, interactive environments, where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game".*

This definition describes most of the main attributes of the games that this research is concerned with, and therefore it is used in this report when discussing serious games, extended with the requirement of entertainment as stated by Abt (1970) and Harteveld (2011). The focus on the experiential nature of games is worth noting in this definition, which is the reason why serious games are so often connected with experiential learning (Harteveld 2011).

While defining the phenomenon is an important step in understanding serious games, it is also beneficial to explore how such games can be used and the ways in which they are useful.

Why use serious games?

One of the definitive sources in the literature of games for serious purposes is Huizinga's *Homo Ludens* (Huizinga 1938). Huizinga's thesis is that only playfulness can lead to innovation (Huizinga, 1938; in Geurts et al. 2007). Geurts et al. (2007) add to this the statement that play breaks the boundaries that regulate reality, and thus frees the player from the necessity of conventional thinking. They also state that games foster creativity by nature and make group work enjoyable and productive.

It is commonly argued that serious games can impact the development of a number of skills positively (Harteveld 2011; Poplin 2012), such as strategic thinking, insight and analytical skills (Mitchell & Savill-Smith 2004). They also affect social skills, for example collaborative skills, as well as the recognition and solving of problems (Mitchell & Savill-Smith 2004). In relation to cognitive learning, researchers claim that questions asked during the gameplay sessions indicate that learning is initiated (Eisenack 2012; Duke & Geurts 2004), and that observations suggest that games are good tools to introduce novel concepts (Torres & Macedo 2000). However, these findings are seemingly unsupported by systematic data collection and analysis. The claims that participants gain new insights in various areas of planning from playing games (Reckien & Eisenack 2010; Mayer et al. 2004; Haug et al. 2011), which can be characterized as improvement in verbal knowledge, are more thoroughly supported by empirical evidence. Limited empirical evidence also suggests that games influence knowledge organization (Haug et al. 2011), and that they provide a deeper understanding about the stakeholders players represent in the game (Haug et al. 2011; Reckien & Eisenack 2010). However, no claims are made in relation to high-level cognitive learning, or about participant learning in relation to the entirety of the goals and aspects involved.

The manifold use of games have been known and taken advantage of for quite some time. In the following sections, a brief history of using games for non-entertainment purposes is presented.

The history of serious games

Many sources on the topic discuss the history of using games for serious purposes, especially in relation to strategic thinking (e.g. Harteveld 2011; Mayer 2009; Duke & Geurts 2004). According to Harteveld (2011), one of the oldest games that is considered to have a serious origin is *go,* a board game originated around 2000 B.C.E. Another commonly known game that served non-entertainment purposes is *chess* (Duke & Geurts 2004; Harteveld 2011), whose strong associations with warfare can be seen in the figures of the game.

Moving on from ancient times, Duke and Geurts (2004) refer to the evolution of war-games during the 18th and 19th century. Shubik traces the origin of these games to 1824, to Lieutenant Von Reisswetz, who created a map game based on board games of the time, to be used for military training (Shubik 2009; in Harteveld 2011). Games remain in use in the military even today, in different forms and scales. The military also uses simulations for training purposes. While simulations are not games, they definitely fall into a related category (Randel et al. 1992). The main difference between games and pure simulations is pointed out by Reckien and Eisenack (Reckien & Eisenack 2013): games have goals as a central feature, whereas simulations generally do not have goals.

In the 20th century, games for serious purposes were also used in other fields. Mayer (2009) refers to the so-called *Von Clausewitz theorem* (1832) to connect war games with policy games. The theorem

states that *"war is a continuation of policy by other means"*. This makes the use of games in policy making a natural extension of war games. Besides policy making, business and management science also utilized games: in the 1960's and 1970's, the use of games became increasingly common in business schools. Furthermore, by the 1980's, games found their place in education in general, through digital games with explicitly educational purposes (Harteveld 2011).

As stated above, policy making and planning are not exceptions when it comes to utilizing serious games. In the following sections, the reasons for this and the history of such games is more thoroughly explored, as it concerns the focus of the research.

Planning games

Certain attributes of serious games make them especially useful in the field of planning. As mentioned, they are beneficial for the communication and understanding of complex, multi-stakeholder situations and environments, commonly associated with planning (Rittel & Webber 1973). They provide a safe place for experimenting with different actions and solutions in such environments (Mayer et al. 2004; Mayer 2009). They also provide a possibility for the inclusion of the social aspect of urban problems and combining it with predictive models in order to facilitate experimentation with future scenarios that consider both the more unpredictable social and the more predictable technical aspects (Cecchini & Rizzi 2001). These attributes make games especially good tools in planning and policy-making, particularly in relation to such topics as climate change (Reckien & Eisenack 2013) and sustainable development (Katsaliaki & Mustafee 2014).

History of games in planning and planning education

According to Mayer's review (2009) on the history of gaming simulation in planning, gaming was brought into policy making and planning through a step-by-step process after World War II. The first games that were utilized in relation to the urban were publicized in the 1960's (Mayer 2009; Cecchini & Rizzi 2001), and articles about games in urban planning were published as early as 1958 (Mayer 2009).

But what led to the emergence of games in the field of planning? The rationalization of policy processes after World War II led to the emergence of the so-called *decision sciences* (Mayer 2009). During this time, all sciences were expected to adhere to the rules of so-called *hard* sciences, like physics (Cecchini and Rizzi 2001, Duke 2000). The decision sciences were originally developed and used for the more structured policy problems, but gradually spread into the fields of health care, housing, education, and urban planning. While primary methods used were systems and policy analysis, these were supplemented with large-scale comprehensive models made possible by the spread of computer technologies (Harteveld 2011). These models were used for simulating processes in urban planning and policy making (Mayer 2009).

Around the 1970's, it was gradually accepted that policy making processes are not well structured and organized, rather they are "messy" and not straightforward to model (Rittel & Webber 1973; Mayer 2009; Cecchini & Rizzi 2001). This realization led to a crisis in model building (Cecchini & Rizzi 2001) and a change in policy analysis (Mayer 2009). Different approaches emerged, such as making the models more and more complex, or turning away from mathematically constructed models towards methods that were more human-centred and sensitive to the wicked nature of the social world (Mayer, 2009).

This either meant a complete abandonment of quantitative methods in favour of qualitative approaches, or a combination of the two (Mayer 2009).

Gaming was very flexible, and was easily adaptable to different contexts and to more strict, quantitative methods and simulation models (Wärneryd 1973), and the use of games was becoming common in many non-military fields at the time (Duke and Geurts 2004; Cecchini & Rizzi 2001). Merging simulations with the more human-driven gaming method resulted in the method of gaming simulation, which was less formal, more interactive than traditional simulations, thus fit better with the prevailing image of planning (Mayer 2009). These games also made it possible for members of these policy processes to be involved in a set of parallel dialogues, a so-called "multilogue" (Duke & Geurts 2004, p.203), in order to enhance decision-making. The emergence of the so-called *free-form* games appears to have accommodated the shift in the approach to planning. Here, the interplay between the participants was much more central than the predefined rules (Mayer 2009; Duke & Geurts 2004).

Games at this stage were mostly used in education and learning (Mayer 2009; Duke 2000). According to Mayer (2009), the early planning games were mostly created by universities and researchers for addressing local needs and were played a limited amount of times and never published. Duke (2000) delivers a personal perspective about the creation of such games, emphasizing that the University of Michigan was a "hotbed" for games, and that by the 1970's and 1980's, other universities around the world have also joined this trend. The use of games in policy making was strongly criticized as lacking strong scientific justification, especially in the case of free-form gaming, whose outcomes were not likely to be replicable given the strong social aspect of the gameplay (Mayer 2009). This criticism spurred the publication of works that tried to create the scientific foundations of gaming, among them Abt's (Abt 1970) *Serious Games* (Mayer 2009). However, their success is debatable, as the criticism and difficulties regarding the use of serious games in planning practice and research is still valid today (Mayer 2009).

Planning games today

The literature distinguishes three different areas for the use of games in the field of planning: research, practice and learning (Mayer et al. 2009; Wärneryd 1975; Cecchini & Rizzi 2001). In research, they can be used for investigating alternative scenarios, and gathering data about the consequences of certain stakeholder actions (Wärneryd 1975). In planning practice, similar to the use of games in organizational settings where they are used to analyse the process and structure of decision-making in an organization in order to help with strategy development (Geurts et al. 2007), they can be useful as tools for analysis of urban development processes and stakeholder relations, and propose strategies in that context. As mentioned above, however, it has historically been argued that games seem more suitable for educational purposes than for actual planning or research (Mayer 2009; Wärneryd 1975). The reason for this is the difficulty the social nature of the games poses for the replicability of the results. These arguments and difficulties cause games to be used mostly for educational and learning purposes in policy making and planning.

Games today are quite commonly used as tools that foster learning in relation to such complex topics as climate change or sustainable development (Reckien & Eisenack 2013; Juhola et al. 2013; Haug et al. 2011; Eisenack 2012). Games are used for experimentation and research in relation to new forms of governance in urban or spatial planning (Mayer et al. 2004), and for enhancing the understanding of simulation models among stakeholders, for example in relation to the interdependencies of actors in the

phenomenon of urban sprawl (Reckien & Eisenack 2010). They can be utilized for enhancing policy making in practice (Geurts et al. 2007). Eisenack (2013) mentions communication towards the broader public, and this use is also emphasized by Poplin (2012), who argues that they can be used for involving the public in urban planning debates, as they are effective as educational tools as well as immersive, which could spur the interest of "outsiders" in the problematic of the planning process (Poplin 2012).

This segment of the chapter explored the concept of serious games, with a specific focus on their history and use in planning. It has shown that they are considered useful in urban planning, and especially in relation to learning. Their benefits in relation to skill acquisition and development is clear, however, a brief review of the research into the field shows that their effect on cognitive learning is less explored.

The following sections contain methodological considerations for the evaluation of game-based learning, focusing on cognitive learning outcomes.

2.2.3 Evaluating game-based learning

As the overview about the history of serious games shows, they have been praised and used for their educational value for decades now, and many sources agree on their usefulness in this area. However, there have been criticisms regarding the lack of scientifically sound research into the actual effectiveness of games as learning tools (e.g. Gosen & Washbush 2004). Recently, growing interest in the field of game-based learning and serious games spurred research with the aim of creating a framework for systematic evaluation of game-based learning by Mayer et al. (2014). The key interest is to identify different variables that influence game-based learning, as well as the development of data collection methods that fit the frame of gaming interventions and are not disruptive for the participant experience. The framework provides a range of research approaches and tools that can be used in the evaluation of game-based learning. It includes a research model, designs and data-gathering procedures, as well as validation tools and research instruments that can be used in this context.

This section introduces the concept of evaluation; the possible targets of evaluation in game-based learning; the process of gaming interventions and its relevance for the measurement of learning outcomes; a proposed research design for evaluating game-based learning; and a list of data-collection methods for evaluating both game-based and cognitive learning. The position taken in this research, where relevant, is clarified under each of the topics.

Evaluation

Mayer et al. (2014 p.367) define evaluation as "[*a*]*pplied research with the specific intention of determining the 'value' of something or someone in the light of past, present or future objectives, tasks, function or other aspects*". Evaluation can be focused on outcomes or on the process itself – in the case of learning this means it can either focus on the learning outcomes, regardless how they have been achieved, or on the internal learning process, regardless of its outcomes (Mayer et al. 2014). Additionally, Mayer et al. (2014) offer a set of categories for learning assessment based on whether the assessed learning occurs *through, during* or *from* the gaming experience. This research is concerned with learning outcomes that stem from the gaming experience, but also investigates the learning process that happens during the game in order to support the findings about the learning outcome.

Kraiger et al. (1993) distinguishes two aims of evaluating training methods, which game-based learning can be considered a part of. The evaluation can concern either whether learning objectives have been met, or whether the learning transfers to reality: whether the learning leads to enhanced performance of the learners in real-life circumstances. Both of these are important in this research, as together they determine whether games are useful tools for learning about the various goals in sustainable urban development. However, the short-term nature of the project means that it is focused on the learning objectives.

Proposed research design

In terms of process in time, game-based learning can be divided into *pre-game condition, gaming intervention* and *post-game condition* (Mayer et al. 2014), and this division guides the measurement of learning outcomes. Based on this division of the process, Mayer et al. (2014) propose a design for research in game-based learning that consists of pre- and post-game measurements, and multiple measurements or observations during the gaming intervention. The design can include a control group and randomization, which is argued for by Gosen and Washbush (2004), although there are plenty of examples for not including a control group in the research design (e.g. Haug et al. 2011; Juhola et al. 2013).

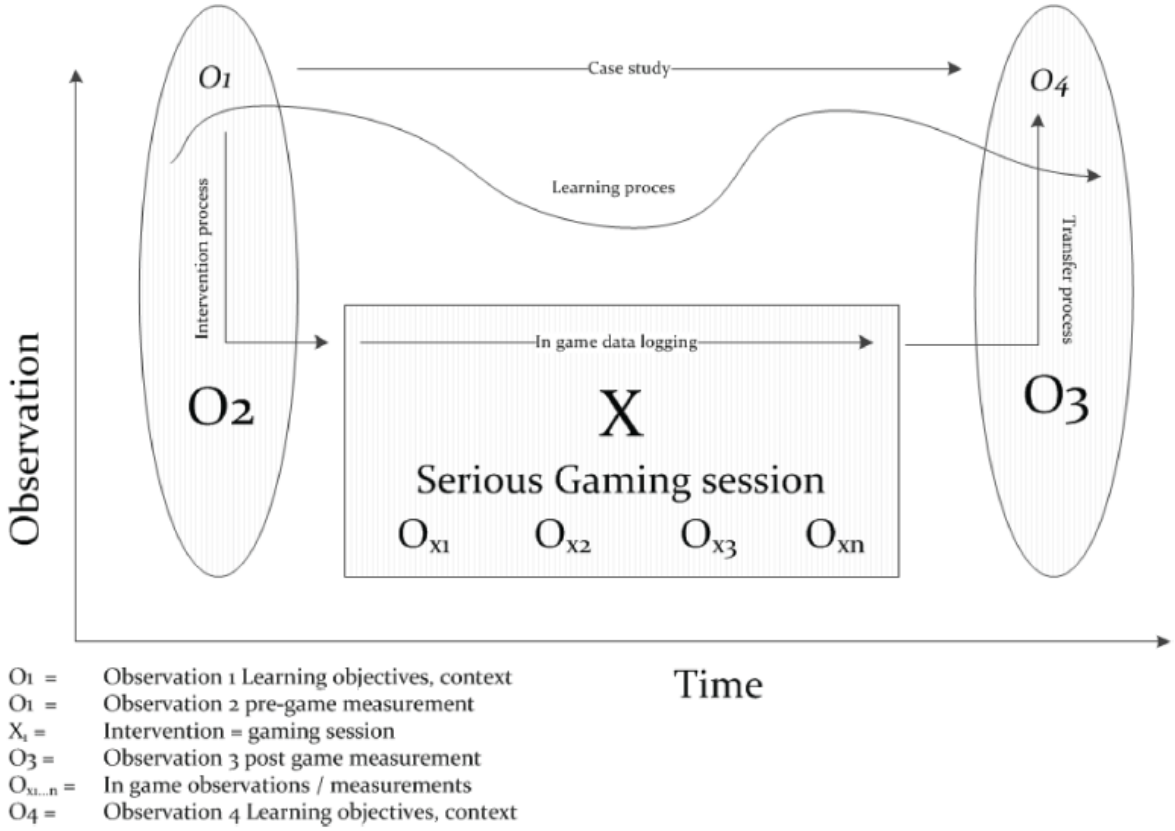

Figure 2.5 - Proposed generic quasi-experimental design for data collection in the evaluation of game-based learning (Mayer et al. 2014 p. 372)

Methods for data collection

Finally, Mayer et al. (2014) offer an overview of data gathering methods for measuring specific aspects of the learning process in game-based learning. These can be seen in Table 2.1.

How		What?	Pre-Game	In Game	Post-Game
Self-reported	Qualitative	Personality, player experiences, context etc.	Interviews, focus group, logbook	Logbook, interviews or small assignments as part of the game	Interviews focus group, after-action review
	Quantitative	Soc-dem., opinions, motivations, attitudes, engagement, game-quality, learning, power, influence, reputation, network centrality, learning satisfaction etc.	Survey, questionnaires, individual or expert panel	In-game questionnaires	Survey, **questionnaires,** individual or expert panel
Tested	Qualitative	Behaviour, skills etc.	Actor role-play, case- analysis, assessment, mental models etc.	Game-based behavioural assessment	Game-based behavioural assessment *Behaviour, skills etc.**
	Quantitative	Values, **knowledge,** attitudes, skills, personality, power	Psychometric, socio- metric tests (e.g. personality, leadership, team roles, IQ)	Game-based behavioural performance analysis	Game-based behavioural performance analysis *Values, **knowledge,** attitudes, skills, personality, power**
Observed	Qualitative	Behavioural performance of student, professionals, player and/or facilitator, others; decisions, strategies, policies, emotions, conflicts, etc.	Participatory observation, ethnographic methods	Video, **audio personal observation,** ethnography, maps, figures, drawings, pictures etc.	Participatory observation, ethnographic methods
	Quantitative	Biophysical / psychological responses, including stress (heart rate, perspiration)	Participatory observation, network analysis, biophysical/ psychological observation	In-game tracking and logging; network analysis, data mining, biometric observation	In-game log file analysis, network analysis

Table 2.2 "*What to measure, how and when?*"(Mayer et al. 2014 p. 374)

The table presents a range of data gathering methods based on the information gathered by them, what part of the experiment they should be utilized and their qualitative or quantitative nature. The methods utilized in this research are marked by using **bold** typeface. The measurements marked in *italics* are added by the researcher.

Kraiger et al. (1993) provide specific guidance about the measurement of learning outcomes on the three cognitive levels. Measuring **verbal knowledge** is possible by using any variety of tests, be that multiple-choice or free-recall, and the tests can rely on either speed or accuracy of information recovery (Kraiger et al. 1993). For the measurement of **knowledge organization**, Kraiger et al. (1993) refer to the term *mental models*, which can be related to the *concept maps* used by Haug et al. (2011) in their research on game-based learning. Evaluating learning on this level means understanding whether learners arrange the relevant concepts in terms of their relationships and importance in the desired way, or, if such a way does not exist, whether there is a change in pre- and post-intervention models (Kraiger et al. 1993; Haug et al. 2011). Finally, **cognitive strategies** can be measured in a number of ways. These include comparing self-assessed learning or understanding with empirical evidence; or asking questions that assess not only whether verbal knowledge is gained, but also whether the reasons

and implications for taking certain steps are understood by the learners (Kraiger et al. 1993). Comparing self-assessed understanding with actual test results have been proven successful by previous studies (e.g. Fisk & Gallini 1989; in Kraiger et al. 1993). Approaches used for the self-assessment are such as the *Perceived Readiness for Examination Performance* (PREP) (Pressley et al. 1987), which requires students to assess their own expected performance in a test by stating the number of questions they are likely to answer correctly. This research focuses on verbal knowledge and cognitive strategies.

So far, this chapter has explored the conflicts between the economic and social goals in sustainable urban development, the importance of preparing planners for dealing with such conflicts and the method of game-based learning as a means to achieve this end. It has also provided methodological considerations for evaluating the cognitive learning outcomes of gaming interventions. However, the games that can be used in this context have to be specifically designed with this purpose in mind. The final part of this chapter explores the problem of creating such games.

2.3 Making serious games

Making games for non-entertainment purposes requires the careful consideration and balance of different elements, in order to create a tool that can facilitate learning about the specific topic at hand. Although there are different approaches to creating serious games, in this research Harteveld's (2011) recommendations are followed for the most part. This decision was made because his approach is holistic both in terms of what the game should achieve and in terms of what it is based on. Therefore, it is adaptable to a wide array of topics and purposes. It also considers the importance of fun in the gameplay.

Harteveld (2011) identifies three elements that are required for a game to serve a purpose well: *reality, meaning,* and *play.* Reality refers to the problem the game is used to educate about, meaning refers to the purpose of the game – in the context of this research it is learning – while play refers to the quality of entertainment that serious games are supposed to have by definition. For a serious game to fulfil its purpose, it is important that all three aspects be successfully implemented. Following Harteveld's (2011) approach, it is important to create a balance between the worlds of reality, meaning and play in the end product.

Other holistic approaches to the design of serious games exist. Among them is Duke's (Duke 1974) tried and tested design method. However, Duke (1974) views game design as a sequential process, where the different steps follow each other according to a certain logical order. Harteveld (2011) on the other hand argues that maintaining the overview is important during all of the steps, as all aspects of the game design are interrelated. This can lead to the review and change of any element of the game, resulting of decisions made in later stages, in order to ensure a good overall outcome. This resembles the approach of qualitative enquiry (Maxwell 2009), and suits the overall flow this research project more readily.

In the following sections, the requirements and methods of implementing the three components named by Harteveld (2011) are explored, tailored to the focus of this study: facilitating cognitive learning in relation to the various, often-conflicting social and economic goals of stakeholders in sustainable urban development processes.

2.3.1 Designing games based on reality

Serious games typically deal with real-life phenomena. Basing a game on reality starts with identifying a *problem* (Duke & Geurts 2004; Harteveld 2011), which Harteveld defines as a part of reality that requires improvement. According to Harteveld (2011), a problem can for example be teaching some knowledge or skill that the target audience lacks, or it can be raising awareness of certain topics.

Creating a game based on a real-life problem requires identification and definition of the problem (Duke & Geurts 2004). Once the problem is defined, it is possible to model it – the resulting model will serve as the basis of the game (Duke & Geurts 2004). Creating the model involves identifying the factors that are involved and those that are not (Wärneryd 1975). In this context, Harteveld (2011) uses the word *factor* to refer to any object related to the problem. This can include actors or stakeholders, artefacts, or phenomena. This covers a broader area than other approaches, such as Wärneryd's (1975) or Duke's and Geurt's (2004), where the main focus is on the actors. Factors can be further ranked based on their influence on the problem, and here Harteveld (2011) identifies two distinct groups: *critical factors,* which are the most influential for the defined problem and *environmental factors*, which are somewhat influential but not focal for the problem as defined. However, real-life planning problems can be excessively complex and involve several interrelated factors (cf. e.g. Rittel & Webber 1973). This means that a simplification of the problem is necessary, which involves a process of choice making in relation to the inclusion of specific factors (Wärneryd 1975; Duke & Geurts 2004; Harteveld 2011).

The factors that are decided to be influential and relevant for the problem at hand are then used to create a model by identifying the relationships between them (Harteveld 2011; Duke & Geurts 2004). An example of this can be seen in Figure 2.6.

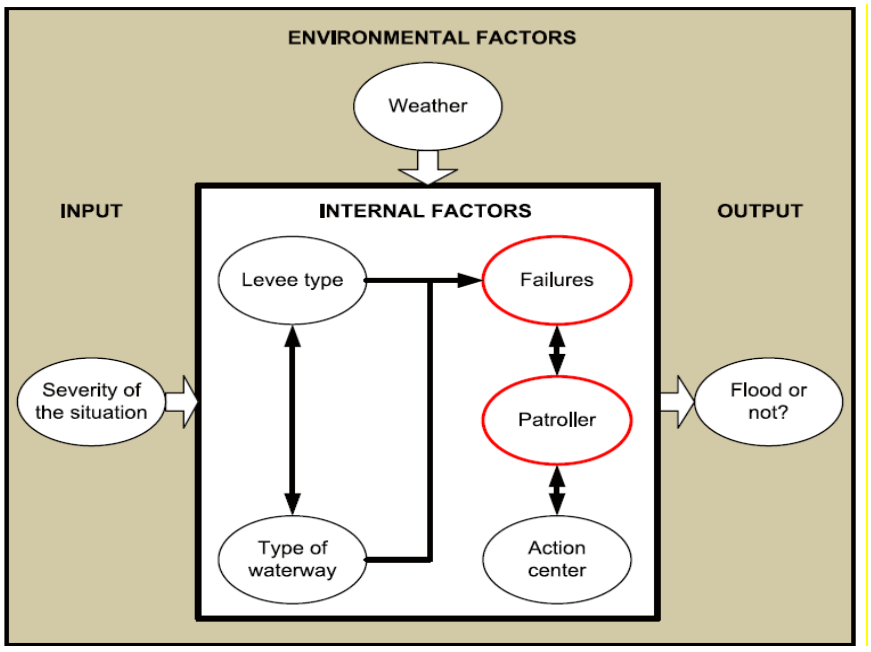

Figure 2.6 - The model of a game created by Harteveld (2011 p. 112)

Wärneryd (1975) and Duke and Geurts (2004) use a model that includes the main actors and their relationship, depicting the possibilities for interaction. Again, Harteveld's (2011) model is broader, involving non-actor aspects. When discussing the model, Harteveld (2011) calls factors that are

considered part of the model *internal factors*. Apart from these, Harteveld (2011) identifies other components of the model as well. These are the *external factors*, which include the *environmental factors* (see above) as well as two additional factors: the *input* and the *output.* He defines input as a "*stimulating factor*" that "*arouses other factors",* and the output as the factors that the performance of the interaction in the model are judged by (Harteveld 2011, p.109). It is important to point out that external factors have an indirect influence on the outputs of the model, since they influence the internal factors.

The next step in creating the game for Harteveld (2011) is to introduce the dimension of time, so that instead of providing a momentary image of reality, the model is capable of depicting a *process.* A process is a *"series of actions or operations conducing to an end"* (Merriam-Webster 2015). Harteveld (2011) states that games are procedural by nature, as the game begins with an initial condition then through interaction with the model the player or players arrive at other subsequent conditions until the desired condition is achieved. This interactive nature is an important characteristic of simulation games (Wilson et al. 2008; Mayer 2009). The desired or "end" condition can be different things: solving a problem or finding the answer to a question; finding or creating a number of something; getting from A to B in the physical reality of the game; or arriving at a specified state (Harteveld 2011). Furthermore, in some games the end condition is specified as a time limit, or in case of round-based games, as a certain number of rounds.

While the process in the game is not necessarily related to reality, building real-world processes into the model of a serious game is a powerful tool (Harteveld 2011). By creating a model that depicts the problem-relevant factors of reality and their relationships and allowing a player to interact with that model, it can serve as practice for the real-life situation (Geurts et al. 2007). However, this requires careful research and consultation on the side of the designers, as implementing relationships in the model that do not adequately represent reality can result in negative consequences for the learning outcome of the players (Harteveld 2011).

Considering the concepts and solutions presented in this chapter can help creating a game that adequately represent the real phenomenon it is based on. However, in order to create a serious game, other aspects are also important. The following sections discuss bringing *meaning* into the game, in order to design a good learning tool.

2.3.2 Designing games with "meaning"

Creating a serious game means creating a tool: something that has purpose, or, in Harteveld's (2011) words, *meaning.* To create a game with meaning, it is important to clarify what the purpose of the game is, what strategy one can apply in order to achieve this purpose, and what *operations* would be useful in the game for it to achieve this purpose (Harteveld 2011). Operations are defined by Harteveld (2011) as mechanisms that are implemented in the game to serve its purpose.

Harteveld (2011) stresses that it is not enough to add features that carry the meaning but are external to the gameplay itself, for example by adding quizzes to the game that periodically disrupt the flow of the game – as in the case of edutainment games. Designing a game with the purpose of using it as a learning tool means that one has to specify the type of learning and the specific learning goals that one expects from the game, and integrate them into the game, in the form of operations (Harteveld 2011). Basing or adjusting the game design to the desired learning outcomes is important, as it leads to more

effective results (Wilson et al. 2008). Meaningfulness, in short, is achieved if a game is designed with a specific purpose, a specific intention in mind besides entertainment, and this purpose has been translated and integrated into the game.

As it has already been clarified, the focus of this research is on cognitive learning, therefore the following sections explore the way facilitation of cognitive learning can be implemented into the design of serious games.

Designing games to facilitate cognitive learning

Harteveld (2011) identifies a number of concepts one needs to take into consideration in order to achieve specific learning outcomes. He lists eight of these concepts, derived from various learning paradigms. These are "*practice, feedback, chunking, reflection, exploration, experience, guidance, and situatedness*" (Harteveld 2011, p. 141). Other lists of such concepts in the realm of game-based learning have also been reviewed, but were not found to be as comprehensive and concise. Insights from the other sources are added where relevant. The concepts, their definitions and their purpose in relation to learning can be seen in the following table:

Concept	What does it mean?	Paradigm
Practice	Repeating the same activity until better understanding is achieved.	Behaviourism
Feedback	Informing the player about whether what he/she is doing is wrong or right. It ensures that the player learns the right things.	Behaviourism
Chunking	People learn by obtaining small pieces (chunks) of information at a time, and organizing them into cognitive structures. Chunking means organizing or acquiring the chunks in manageable units. The cognitive structures are committed to long-term memory and are easily retrievable.	Cognitivism
Reflection	For learning to be effective, the acquired information has to be processed on a higher cognitive level. This happens through reflection.	Cognitivism
Exploration	By making the game exploratory, players can decide how they want to play the game. This allows for self-directed or self-initiated learning, where the learner can decide what they need to learn and how.	Humanism
Experience	Learners can actively construct knowledge based on a concrete experience through a cycle of reflection and abstraction (Kolb 1984).	Constructivism/ Humanism
Guidance	Makes it possible to translate spontaneous concepts that emerge during the game into meaningful scientific concepts.	Humanism
Situated learning	Performing the actual task in an authentic situation (socially, materially, culturally) is the only way to acquire real knowledge.	Socio-constructivism

Table 3.2 – Important concepts to be considered when designing games as learning tools (based on Harteveld 2011)

Practice and *feedback are* rather straightforward aids to learning, therefore they are not discussed in further detail here. *Chunking* is more problematic, and more essential to remember in game design, as it can have a large impact in the quality of the game. What Harteveld (2011) refers to as *chunking*, Duke and Geurts (2004) calls the *loading of information.* It is important that players receive the necessary, and only the necessary information at the beginning of the game. As the game progresses and players begin to process and understand the initial load of information, they tend to begin asking questions on their own (Duke & Geurts 2004), which signals that they are able to process more detailed information as well.

On the topic of *reflection*, it is especially important to make it conscious in games, and Harteveld lists three reasons for this (Harteveld 2011). First of all, trial-and-error approaches in games might lead to good results without proper understanding of the underlying reasons from the players. Second, games by nature are not good at providing opportunities for reflection, as they lead to a certain level of excitement, which causes a more superficial processing of information. Finally, games are rich in stimuli, which might result in less attention from the players on information that is important in terms of the purpose of the game.

Situatedness can be related to Wilson et al.'s (2008) category of *representation*. Harteveld (2011) argues that the situated nature of game-based learning, in other words the ability of games to represent reality, enables players to learn skills and strategies in context, as opposed to in isolation. Wilson et al. (2008) furthermore states that the psychological representation is more important than physical representation. Basing the game on a real-life process usually means that some level of situatedness can naturally be expected. It is important to point out that while some level of similarity between reality and the game is definitely beneficial, higher fidelity is not proven to necessarily lead to better learning outcomes, and that in some cases a departure from reality might actually be more effective (Hays & Singer 1989; in Harteveld 2011).

It is not easy to translate the experience from a game to an abstract construct – into cognitive knowledge. *Guidance* is necessary to achieve this. One way to aid the process is allowing players to experience the gameplay with peers or with the help of a facilitator. This relates the enhancement of the learning experience to the theory of social learning: the help of peers or the facilitator in problem solving improves learning outcomes (Vygotsky 1978). Another, related strategy is if player are encouraged to explain their rationale, their strategies behind certain actions to others – again, to other players or to the facilitator (Harteveld 2011). A study on this topic points to players being unable to process knowledge without encouragement from specific in-game elements or the facilitator to utilize one of these techniques (Egenfeldt-Nielsen 2007).

A note on the role of debriefing

In relation to guidance and feedback, **debriefing** as a part or extension of serious games has to be mentioned. Many authors agree that debriefing should be an integral part of serious games, as it ensures that the concepts that the game deals with are clearly understood, and it helps to avoid misunderstandings (Crookall 2011; Duke & Geurts 2004; Eisenack 2012). Since games do not reflect reality completely, it is vital that the crucial differences between the model of the game and reality are explored and explained (Eisenack 2012). This means that the debriefing helps to achieve learning by clarifying the connection between reality and the game.

According to Duke and Geurts (2004), the main aim of debriefing is two-fold: beside its role in the clarification of the contents of the games and its relationship to reality, it also allows players to vent about their experience in the game and explain their decisions and mistakes. This latter role of the debriefing also makes it helpful for the refinement of the game for further sessions. During the discussion, new ideas or viewpoints might arise that can make the game more useful or fun in the future (Duke & Geurts 2004; Eisenack 2012). Therefore, including a debriefing in the game session is useful for both the participants and the facilitator or game designer.

Closing the discussion about *meaning* in serious games, one more thing is important to note. The purpose of the consideration of the abovementioned tools that aid learning is to ensure that *transfer* takes place (Harteveld 2011) – that the knowledge gained in the game transfers into useful knowledge in practice. This is an important insight in the realm of this study, as it determines whether games can be useful tools for providing planning students with knowledge they can use in practice.

The previous two segments explored the aspects of reality and meaning in serious game design, both of which are vital for creating a good learning tool. However, it has already been discussed that it is important that the purpose of the game be properly integrated into the gameplay, so the closing segment of this chapter presents a brief explanation of the way this can be done.

2.3.3 The role of "play" in serious games

Designing a good game means designing good gameplay as well, as without that, a game cannot be entertaining. This is true for serious games as well – entertainment is part of the operational definition of the term in this report. During this project, the creation of the game happened in collaboration with a group of students who handled the questions of genres, gameplay and balance, belonging to the world of *play* in Harteveld's (2011) system. Therefore, these topics are not addressed in detail. However, one aspect is important to mention here. Harteveld (2011) discusses the necessity of a clear goal in the game, together with a clear purpose of the game. The two are closely related, but should not be confused with each other. In the words of Harteveld (2011 p. 180), *"in achieving the goal in the game, the purpose of the game is (hopefully) achieved."* This means that the purpose of the game should be considered when deciding on the goal the players are aiming to achieve in the game, at the beginning of the game design process, as well as throughout the process, to ensure that the final gameplay is also in harmony with the goal and the purpose.

The purpose of a serious game is related to the world of *meaning* (cf. Chapter 2.2.2). It expresses what the game itself tries to achieve (Harteveld 2011), such as facilitating learning in a certain area of expertise. The goal on the other hand is what the players are trying to achieve in the game. A clear goal, in a serious game, also has to be accompanied with a way of achieving that goal that is not reliant on luck, but rather on deliberate action by the player (Harteveld 2011). This serves to avoid frustration on the players' part. Therefore, it is a part of the world of *play*.

This chapter discussed the relationship between planning, learning and serious games. It showed the importance of understanding the conflicts and synergies between social and economic aspects of sustainable developments in order to enable planners to facilitate sustainable urban development processes successfully. Furthermore, it discussed the possible role of game-based learning in preparing planners for this task. It also introduced the concept of serious games, and the use of such games in the field of planning. The methodological requirements of the evaluation of game-based learning were discussed, as well as those of designing serious games.

The following chapter details the design of the research and the methods of data collection utilized in addressing the problem and answering the research question.

3 Methodology

This chapter presents the methodology utilized in this research project, which investigates the cognitive learning effects of serious games in relation to conflicting goals and complex trade-offs in sustainable urban developments through an exemplifying case study. Besides detailing the overall design of the research, the chapter also lists the primary and secondary data sources utilized in the research, such as strategic planning documents, scientific and grey literature, interviews and questionnaires, audio and video recordings of the gameplay sessions. As the game was also created as part of the research project, the method of game design is also discussed. The data collection protocol details the specific methods of data collection during the research and the way the collected data contributed to the research. Additionally, relevant ethical considerations in relation to the treatment of the human participants of the research, such as questions of anonymity and confidentiality are described.

3.1 Research design

The following sections describe the overall design of the research project aimed at investigating the cognitive learning facilitated by a serious board game about the social and economic planning aspects of the development of a new urban district in the North Harbour in Copenhagen, Denmark.

3.1.1 Research question and propositions

The research aims to answer the following question:

How does a game affect the cognitive learning of planning students in relation to achieving different, often conflicting social and economic goals of stakeholders in a sustainable urban development process?

From personal experience as well as based on the state of the art, I expect that by providing a platform for experiential learning, the game will facilitate cognitive learning on different levels (specifically in relation to verbal knowledge and cognitive strategies) for students. More specifically, I expect that playing the game will enable the participants to understand their roles and the goals attached to them. The effect the gameplay has on the learning will also be observable in the participant interactions, which I expect will change during the course of the gameplay and show patterns that indicate that learning occurred. Finally, as a result of the gameplay and the interactions between players, the participants will gain higher-level cognitive understanding about their role-specific goals and the ways in which they are able to reach them. Thus, the game will facilitate learning on different cognitive levels – on the levels of verbal knowledge, and cognitive strategies (cf. Kraiger et al. 1993).

3.1.2 Philosophy of science

The research presented in this report is rooted in a **pragmatic** philosophy of science. With this philosophical background, the use of mixed methods research is regarded as both appropriate and useful (Johnson & Onwuegbuzie 2004). Within pragmatic thinking, the importance of choosing and pairing research methods in order to achieve the best answers to important research questions is stressed. The outcome-oriented nature of pragmatism allows for the selection of methods and data that best serve the research purpose, and this makes it possible not to limit the methodological choices based

on the purist qualitative and quantitative distinction. Therefore, this research made use of a combination of qualitative and quantitative methods both during the data collection and the analysis.

Pragmatism, as the researcher understands Peirce's (1878) description, is primarily interested in the observable actions and habits that thought produces, and claims that any difference in thought or meaning is only relevant if it leads to a difference in actions and habits. In other words, differences in the causes of observable outcomes are only relevant if the outcomes are different. This means that by observing outcomes, and only by observing outcomes and their differences, one is able to identify differences in the causes of those outcomes. The conclusions drawn in the end of this project report are based on the analysis of data collected through observation of the participants during the gameplay and control group sessions, as well as self-observation of the participants, reported through questionnaires and interviews. According to pragmatism, based on this observational data is possible to draw conclusions about whether playing the game affected the learning of participants.

The approach to drawing conclusions in this research can therefore be described as **abductive** (Douven 2011). The researcher investigates the changes in knowledge between the beginning and end of the gameplay sessions, and accepts that a likely cause of these changes is the gameplay – even though alternative explanations might exist.

As opposed to positivist philosophy, pragmatism as defined in the writings of Peirce (1878) acknowledges the differences in the individual perception of reality, but, unlike constructivism, still emphasizes the existence of a "real" truth. This truth can only be identified through scientific research, and it is what all scientists should arrive at in the end, no matter what methods and points of departure they choose. However, this is not an immediate result. Scientists converge towards the real truth, but not necessarily arrive at it in the end of the individual research. This divergence happens through constant challenging of one's own opinions as well as the commonly accepted belief (Peirce 1877).

3.1.3 Case study research

In order to address the problem introduced in Chapter 1 and answer the research question, a case study was conducted with planning students at MSc level at Aalborg University in Denmark. A case study is appropriate in this research as it is led by a "how" question and uses a number of different methods, both qualitative and quantitative, in order to investigate contemporary events. The research design in large part follows Yin's recommendations about case study research (Yin 2009).

The main parts of the research and their relationships can be illustrated with the help of the following figure:

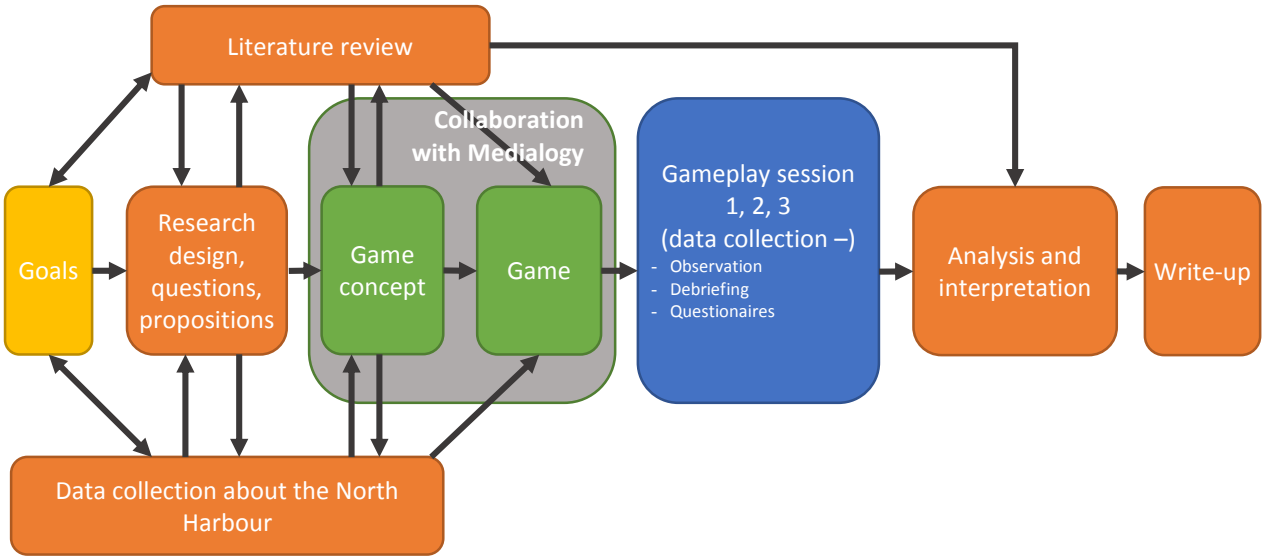

Figure 3.1 - Research design

The arrows in the figure indicate the main logical connections between the different parts. However, it is important to note that the reflexive nature of the research process allows for changes to be made in any element of the design or even the sequence of elements in case some information recovered during the research process makes it necessary (Maxwell 2009). Because of this, the chart acts more as a guideline and provides an overview of the main tasks. It also makes the creation of a timeline possible based on the preliminary design of the process. This does not mean that the decisions made in the early stages of the research cannot be altered in a reflexive manner throughout the process. The most important alterations and the rationale behind them are discussed in Chapter 8.

The case chosen for investigating the problem is regarded as an **exemplifying** case (Bryman 2008). Aalborg University offers an education that is focused on problem-based learning, and therefore has a strong emphasis on experiential learning, but the students typically come from a variety of cultural and educational backgrounds. In this sense, the case presents an example of the commonplace planning education situation. Therefore, the circumstances of the case allow for drawing conclusions on a broader scale.

The main **unit of analysis** in the study is at the level of individuals – planning students playing the game. The research is directed at investigating the ways in which the gameplay sessions in board gaming affect the cognitive learning of planning students in relation to understanding and achieving the role-dependent goals they have in the game.

The **site** for the case study – Aalborg University – was chosen for its convenience in approaching the subjects of the study as the researcher is also a student of this University, as well as their likely familiarity with the context, the typical problems and concepts present in urban planning in Denmark. This made it easier for them to identify with the setting of the game. The international nature of the programs also allowed for observations about students from various cultural backgrounds.

The **study population** for the research is planning students at MSc level at Aalborg University. This includes the students enrolled in the Urban Planning and Management program at the Aalborg Campus, and the Sustainable Cities program at the Copenhagen Campus in the spring semester of the 2014/2015 academic year.

3.1.4 Analytical approach

The data collected through the empirical case was analysed in a **pattern matching** manner (Yin 2009), where specified outcomes of the intervention (in the form of gameplay sessions) are investigated in order to see whether the initial propositions were correct: playing the game led to an increase of the verbal knowledge and cognitive strategies of participants, and the effect of the game on the learning process was observable through changes in participant interactions during gameplay.

Based on the propositions, the following patterns were expected:

- The verbal knowledge of players would increase from the pre-game to the post-game test.
- The cognitive strategies in relation to the game would increase during the session, measured by the similarity of self-assessed and tested knowledge of participants.
- The players would behave in ways that show signs of learning about the various goals in the game during the session.

The analysis used both qualitative and quantitative methods, which, together with the information gathered from previous research and presented in the state of the art, complement each other and enable a triangulating approach in the analysis. The state of the art informed the theoretical position of the researcher, which led to the propositions and the expected patterns. This was then compared to the case-specific results of the analysis of the quantitative data, which measured the changes in the cognitive knowledge of the participants between the beginning and the end of the gameplay session, and was further supported by the analysis of the qualitative observational data from the sessions, which highlighted signs of learning during the gameplay. As the theoretical position was not specific to the case but covered a more general field in relation to the problem and research question, it made it possible to draw more generalized conclusions on the case-specific results.

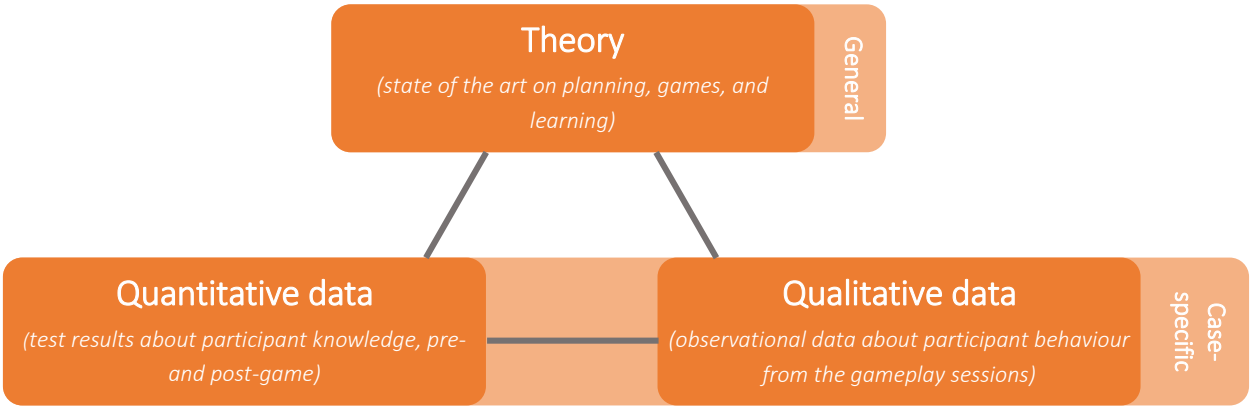

Figure 3.2 - Illustration of the triangulating use of data in the research

The line of reasoning can be classified as **abductive** (Douven 2011), in which the researcher reasoned that the likely explanation for changes in the knowledge of participants between the beginning and end

of the gameplay sessions can be attributed to the game, even though alternative explanations, such as participants learning from each other or the facilitator, can also be possible.

Measuring learning

Following the recommendations of Kraiger et al. (1993), **verbal knowledge** was measured with the help of a combination of multiple-choice and free-recall tests, where the focus was on accuracy of information recall. The acquisition of **cognitive strategies** was measured by asking students to assess their own knowledge and understanding of goals and required actions both in the beginning and end of the gameplay session, and comparing the results of this self-evaluation with empirical evidence in the form of their measured verbal knowledge. The self-assessment of understanding took a much simpler form than those prescribed by Kraiger et al. (1996), simply asking students to assess the level to which they understood certain areas of the game and the goals.

The measurement of participant knowledge was based on the results of the questionnaires distributed at various stages of the workshops (see Appendix A, B and C).

Verbal knowledge

The questionnaires covered various aspects of the goals of each player, as well as certain goals of the planners. For the analysis, some of these questions were disregarded. The questions selected for the analysis are those that were asked both in the pre- and post-game questionnaire, and those that were identical for both the planners and the consultants, in an effort to make the data more uniform. Accordingly, the answers for the following questions are considered in the analysis:

- What is/was your goal in the game?
- What types of structures would/did you place next to each other?
- Should there be more residential or commercial buildings on the board?
- How much social housing should there be on the board?

During the preliminary stages of the analysis, answers to questions where the participants were asked to provide examples or to choose the correct answer form a list were rated according to their level of correctness and completeness on a five-point scale by the researcher in order to allow for easier analysis. This scoring was done on a scale of 1-5 according to Appendix E, and resulted in quantitative data (Appendix F), which provided a better basis for the analysis.

Cognitive strategies

Measuring changes in the cognitive strategies of participants was done by comparing the self-assessed and tested knowledge of participants both pre- and post-game, and comparing the two sets of data, in order to see whether the level of similarity between self-assessed and tested changed during the course or gameplay. The comparison was done based on the following figure:

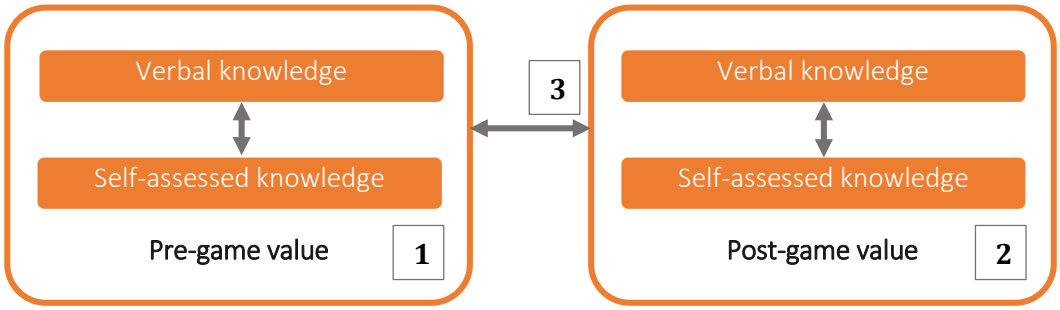

Figure 3.3 - Steps of the analysis for investigating changes in the cognitive strategies of participants

The value of self-assessed knowledge was based on questions relating to the same areas of the game as in the case of verbal knowledge, requesting the participants to rate how much they agreed with the following statements on a five-point Likert scale (1 – not at all; 5 – completely):

- I know what my goal is/was in the game.
- I know what types of structures should be next to each other.
- I know whether there should be more residential or commercial buildings on the board.
- I know how to figure out how much social housing there should be on the board.

The results are comparable with the corresponding levels of verbal knowledge, as the scoring system utilized there corresponds with the five-point scale. A "not sure" option was also included, which was assigned a numerical value of 0, in order to make it possible to include in the evaluation.

Tracking learning based on observational data

When tracking the learning process of participants during the gameplay session based on the audio recordings, instead of looking for measurable signs of increasing knowledge, expressions and exchanges of knowledge about others' roles and goals were identified, and patterns were sought to see whether these expressions changed in intensity or depth throughout the gameplay sessions. The focus on the goals of other players was chosen so it complimented the questionnaire data on the players' own goals in order to cover the field of the study better. It was an exploratory process, where categories for investigating the data in-depth emerged during the preliminary stages of the analysis.

The analysis attempted to find quantifiable changes in the nature of player interactions, in order to see whether changes in participant behaviour occurred during the sessions. This could provide insights on the learning process of participants in relation to the different goals of players during gameplay. The observation was based on the audio recording of the gameplay sessions (see Appendix D).

3.1.5 Main data sources

The research made use of both qualitative and quantitative data, following the advice of Johnson and Onwuegbuzie (2004). The following sources were used in order to collect and analyse data during the research.

A **state-of-the-art literature review** was written based on peer-reviewed journal articles, books, and online media sources on the topic of serious games, planning games, learning through games and its evaluation, and making games that facilitate learning.

Planning and legal **documents** were analysed in order to gain an understanding about the development process in the North Harbour, Copenhagen.

Site visits were utilized as a means to meet stakeholders and experts on location at the North Harbour, as well as to gather visual data and other information available at the Himmel og Hav exhibition site.

Narrative **interviews** were used as a data-collection tool to gather information about the development in the North Harbour, as well as with experts in the field of serious game design in urban planning.

In order to investigate whether the game influences the learning of planning students in relation to achieving diverse and often conflicting goals in an urban development process, a set of workshops with gameplay sessions were carried out. During these workshops, the game created about the development process was played by the participants. During the sessions, **audio recordings** were created, to allow for observation of the behaviour of participants, in order to provide empirical evidence that the game affected their learning.

Questionnaires were used as a quantitative data collection method as part of this research. Questionnaires were used for gathering data about the learning of the participants, their experience with the field of planning, and basic demographic information.

3.1.6 Creating the game

The game was created in collaboration with 7th semester Medialogy students Nicholas Egede Bukdahl, Mindaugas Augustas Pronckus, Dennis Godtfredsen and Simonas Garbaciauskas as part of their semester project. The game is presented in detail in Chapter 4.2. The rules of the game are attached to this report as Appendix G. This section serves to document the process that led to the final product.

The purpose of the game was formulated based on the state of the art in sustainability planning. It addresses the problem of having to prepare planners to deal with the conflicts and synergies between stakeholder goals in relation to social equity and economic growth in sustainable urban development, particularly in a newly developed urban district. The game is largely based on the tools and goals of the City of Copenhagen and CPH City and Port Development in relation to the social and economic sustainability aspects of the development process in the North Harbour, Copenhagen, and can be classified as a competitive strategy game with role-playing and puzzle elements.

In accordance with Harteveld's (2011) recommendations, the goals the players are attempting to reach have been selected to compliment the purpose of the game. The players are representing various stakeholders in the development process, and they have to reach selected goals based on those of the respective stakeholders.

For the creation of the model that serves as the basis of the game, information was gathered about the process of development in the North Harbour, with special focus on social and economic aspects, such as the main issues in terms of the economic feasibility of the development or the main expectations in relation to social equity. The information originated from legal and planning documents (see a detailed list in Chapter 3.2) and interviews with Rita Justesen, the head of the planning and architecture department of CPH City and Port Development as well as Patrick Driscoll and Silvia Dragomir, planning professionals with experience both in relation to the development process in North Harbour and serious games. The information collected is presented in Chapter 4.1. The data collection led to the identification

of the main internal and external factors of the development process, among them the main stakeholders, their relationships, the nature of their influence on the development of the district, as well as their goals. Based on this information, an operational model was created for the game (see Chapter 4.2.1), together with the process that served as the basis of the gameplay. The creation of the model and process was guided by the recommendations of Harteveld (2011; see Chapter 2.3.1). While internal factors were considered in defining the roles and interactions in the game, environmental factors were included in the form of mechanisms that are independent from the players: *action cards*, which players have to draw and they influence the actions they can take in a round based on, for example, societal or economic pressures. In order to ensure that the development process was adequately represented, once the prototype of the game was available, further consultations were sought with planning professionals working on the North Harbour project at CPH City and Port Development. These professionals were asked to review the game and provide feedback, and their opinion was that the game is a useful tool for introducing planning students to the problems at hand.

The development process was not the only thing influencing the design of the game. The purpose of it as a learning tool also affected the decisions. Again, Harteveld's (2011) recommendations can be cited as guidance in this matter (see Chapter 2.3.2). *Feedback* mechanisms were built into the game in the form of scoring, which helped players assess their performance in relation to achieving their goals in the game, such as higher income scores indicating better performance for the consultants (developers), or the planners receiving bonus points for achieving the balance of various functions. *Situatedness* was naturally provided by the game, as it provided a physical representation of the urban district. The physical structure of the game resembles a model typically used in urban planning and architecture, a scaled-down three-dimensional representation of reality. As the game progresses, the number of structures in the model increases, evoking the image of a district under construction. Besides the physical representation, the structure of gameplay, the relationships among the roles as well as the differences in the ways the different roles interact with the game provides a high level of psychological representation of reality. Details about the physical and gameplay structure of the game can be found in Chapter 4.2. *Exploration* was encouraged by the designers by allowing players to experiment in the game instead of providing strategies that definitely lead to victory. In order to allow for *reflection* and some level of *guidance*, a short debriefing was included in the design of the gameplay workshops, where the participants were encouraged to compare the game with reality.

Finally, gameplay considerations also influenced the final design of the game. The most important of these, the consideration of in-game goals and its connection to the purpose of the game was already discussed. Otherwise, decisions in relation to the gameplay were made by the collaborating group of Medialogy students, who proposed game concepts and physical representations based on the information relayed by the researcher. The original game concepts went through an iterative design process, where proposals were presented, discussed, tested, and assessed based on their playability and representativeness of reality. These assessments then initiated changes in the proposals and eventually, after multiple cycles, led to a final prototype.

One of the questions that was central during this process was the balance between the representation of reality and the relative simplicity and playability of the game. The original proposal involved all social aspects of the Sustainability Wheel (The Urban Design Centre, n.d.; Appendix I). However, this presented a complexity that the designers felt was not plausible to understand during a single play-through.

Therefore, the sustainability aspects were limited to the following: city life, urban space, and diversity. Furthermore, questions of balance between the different roles both in terms of relative power in the development process (in reality) and available actions (in the gameplay) were considered numerous times.

3.1.7 Workshops

The goal of the workshops in the research was to investigate game-based cognitive learning in relation to the goals that the players have to achieve in the game. They facilitated the main body of primary data collection in order to address the goal of the research and answer the research questions.

Following the suggestion of Mayer et al. (2014), the design of the data collection during the workshops followed a single intervention, *ex-ante* and *ex-post* intervention data collection method (cf. Mayer et al. 2014; Mark & Reichardt 2009), with continuous data collection during the workshops. *Ex-ante* questionnaires were distributed both before the beginning of the workshop and before the start of the gameplay sessions, while *ex-post* investigation took form in a single *ex-post* questionnaire. The entire gameplay session was recorded in audio format to allow for structured observation of participant interactions. The design of the data collection process can be illustrated with the following figure:

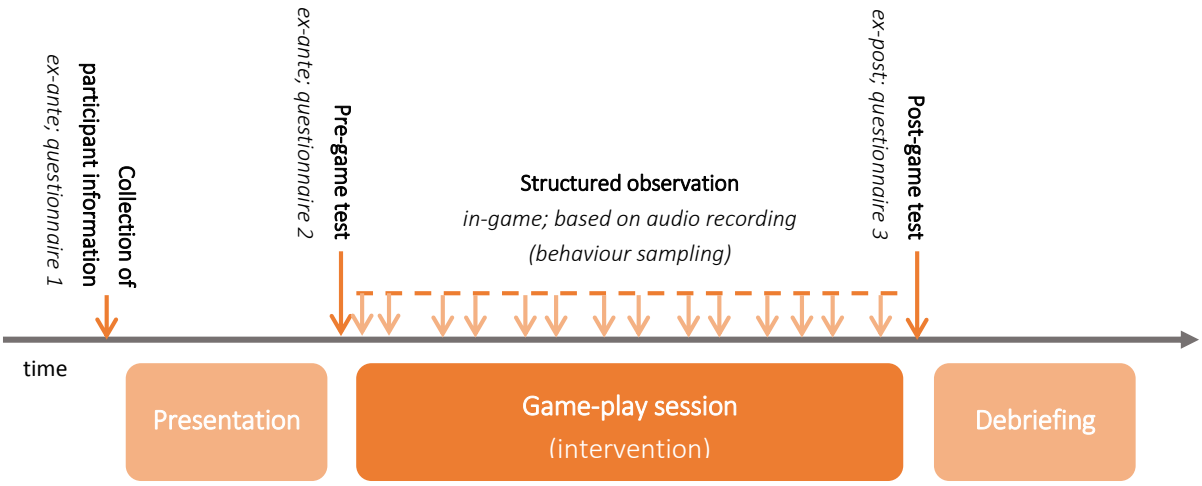

Figure 3.4 - The design of the data collection process during the workshop

The following table contains information about when the different data collection methods were used during the session and what the gathered data relates to:

When	What	How	How
Ex-ante	Cognitive knowledge (pre-intervention)	Self-assessed	Self-assessment through questionnaire
		Measured	Knowledge test through questionnaire
In-game	Learning (cognitive learning)	Observed	Structured observation based on audio recording
Ex-post	Cognitive knowledge (post-intervention)	Self-assessed	Self-assessment through questionnaire
		Measured	Knowledge test through questionnaire

Table 3.1 – Data collection methods in relation to the workshops

Outline of the gameplay sessions

The workshops for the gameplay sessions were approximately 3,5 - 4 hours long each (allowing for brief breaks between the different parts) and were structured in the following way.

Prior to the gameplay session

At least a week before the sessions an invitation was sent to the participants via e-mail (see Appendix H), including a short introduction to the researcher and the project, the schedule for the session, and a link to an online version of Questionnaire 1 (Appendix A). The letter also discussed questions of anonymity and treatment of personal information.

Introduction

Details about the North Harbour development and the stakeholders involved and their goals were outlined in the form of a brief presentation. The goal of this was to familiarize the participants with the development process, and to achieve a basic understanding of the main concepts involved – the social and economic aspects prioritized by the different stakeholders, and the trade-offs. The main rules of the game were also explained. The introduction took 30-45 minutes.

Assignment of groups

Following the introduction, students were divided into groups of 5 or 6 using a random probability sampling (Henry 2009) technique, assigning them to groups based on numbers given to them following their seating arrangement. Each group played the game at the same time and in the same room.

Gameplay session

Following a brief break that allowed for the formation of groups, the participants received the game and were provided with the rules. The participants have received the rules prior to the workshop, but at this point, the roles and their specific goals as well as the scoring system were explained in some detail in order to ensure that all participants were aware of the most important rules.

In accordance with the rules of the game, the roles were assigned. During the first workshop, the players decided which roles to play, and during the second workshop the roles were assigned randomly.

The three sessions lasted 8, 7 and 7 rounds respectively, therefore the events happening in each of the rounds were considered comparable. As Stage 1 was only three rounds long in Sessions 2 and 3, the comparison of the rounds was done according to the following table:

Session 1		**Session 2, 3**	
Pre-game		Pre-game	
Stage 1	Round 1	Stage 1	Round 1
	Round 2		Round 2
	Round 3		Round 3
	Round 4		
Mid-game		Mid-game	
Stage 2	Round 1	Stage 2	Round 1
	Round 2		Round 2
	Round 3		Round 3
	Round 4		Round 4
End-game		End-game	

Table 4.2 - Comparison of rounds in the various gameplay sessions

Once the roles were assigned, Questionnaire 2 (Appendix B) was distributed. The sessions were ended by the researcher after 1,5-2 hours of play. Following the gameplay sessions, Questionnaire 3 (Appendix C) was distributed.

Debriefing

After the sessions, a discussion about the game and the urban development process at North Harbour was initiated. The discussion was facilitated by the researcher and served as a debriefing (cf. Chapter 2.3.2). The focus was on discussing the game in the context of the development process in the North Harbour – the commonalities and differences between the game and reality. During the debriefing, field notes were taken. The notes relate to comments about the game and its effects on learning, on participant attitudes, etc.

3.2 Data collection protocol

The following sections detail the methods for collecting primary and secondary data in this research. The secondary data was collected through review of a variety of literary sources. Primary data was collected through both qualitative and quantitative methods: site visits, interviews, pilot tests of the game, questionnaires and observational data from the workshops. Combining qualitative and quantitative approaches in the research of game-based learning is propagated in the literature (cf. Mayer et al. 2014).

3.2.1 Collection of secondary data

The secondary data collected during this research served the purpose of understanding the rationale behind using games for serious purposes and specifically in planning, as well as understanding the phenomenon of learning and the ways in which games are useful for facilitating different types of learning. Secondary data was also used to aid the comprehension of the context of the North Harbour development, which was used for creating the board game as part of this project. It was also utilized for gathering information about planning education at Aalborg University.

Literature review

Books

The review of relevant literature on the topic of serious games (such as educational games) started with a review of the book *Triadic Game Design* by Casper Harteveld (2011), and expanded on it by reviewing further sources found in the book. The book is useful as a review on historical and theoretical perspectives on serious games, as well as a practical guide for the design of games. It is important to point out that the book, and indeed much of the research in the field focuses primarily on digital games. However, a majority of the design concerns and the design elements can be used in the design of serious board games as well. On the topic of planning theory the book *Readings in Planning Theory* (Fainstein & Campbell 2003) provided valuable guidance.

For theoretical and practical guidance on research design, data collection and analysis methods, numerous books have been used. Among these the most important are Robert K. Yin's *Case Study Research* (2009), as well as selected relevant chapters of *The SAGE Handbook of Applied Social Research Methods* (Bickman & Rog 2009).

A selection of Peirce's works (Peirce 1877; Peirce 1878) was used to provide an understanding of the pragmatic theory of science and its implications.

Peer-reviewed journal articles

For finding peer-reviewed journal articles for the state-of-the-art literature review on planning education, the conflict between the various goals in sustainability, gaming in planning and learning through games, I used some specifically relevant articles as starting points together with the books mentioned above. Most of the articles focus on the use of games in relation to learning in the context of planning (e.g. Reckien & Eisenack 2010; Eisenack 2012; Haug et al. 2011; Juhola et al. 2013). This led to further sources that are referred to in these articles as well as keywords that are commonly used in the articles. I searched the online database of the journals Simulation & Gaming and Planning Education & Research, as well as the library database at AAU for peer-reviewed articles. Keywords used were "learning game", "serious game", "planning game". The articles found were screened based on their abstracts; seemingly relevant articles were downloaded and screened for relevance before being included in the literature review.

The model for the assessment of game-based learning was mainly informed by Mayer et al.'s (2014) recent research and recommendations on the subject. The article contains extensive references to validated assessment and evaluation methods used in the field.

Peer-reviewed literature was also used for supplementing the data collection protocol and research design, particularly in relation to mixed-methods research, where Onwuegbuzie's work was especially drawn upon (e.g. Johnson & Onwuegbuzie 2004).

Planning documents and strategies

For information about the development of the North Harbour, the research draws significantly on municipal and development strategies and documents released in relation to this project. These include the Urban Strategy for the North Harbour (CPH City and Port Development, 2009) and the updated document from CPH City and Port Development, which presents the detailed strategy for the Inner North Harbour area (CPH City and Port Development 2012). Additionally, the relevant attachment to the Municipal Plan for the City of Copenhagen (The Urban Development Centre 2013), the Local Plans of the relevant areas (e.g. City of Copenhagen 2011), and the Fingerplan (Danish Nature Agency 2013), which serves as the spatial strategy for the Greater Copenhagen Area have also been reviewed.

Another important source of information about stakeholder goals is the Sustainability Tool of the City of Copenhagen (City of Copenhagen, n.d.), which contains the specific stated aims about sustainability for new urban developments. It is used as a tool for evaluation of large-scale projects and communication with the developers. As the online version was not available at the date of the publication of this report, see the written components of the Tool in Appendix I.

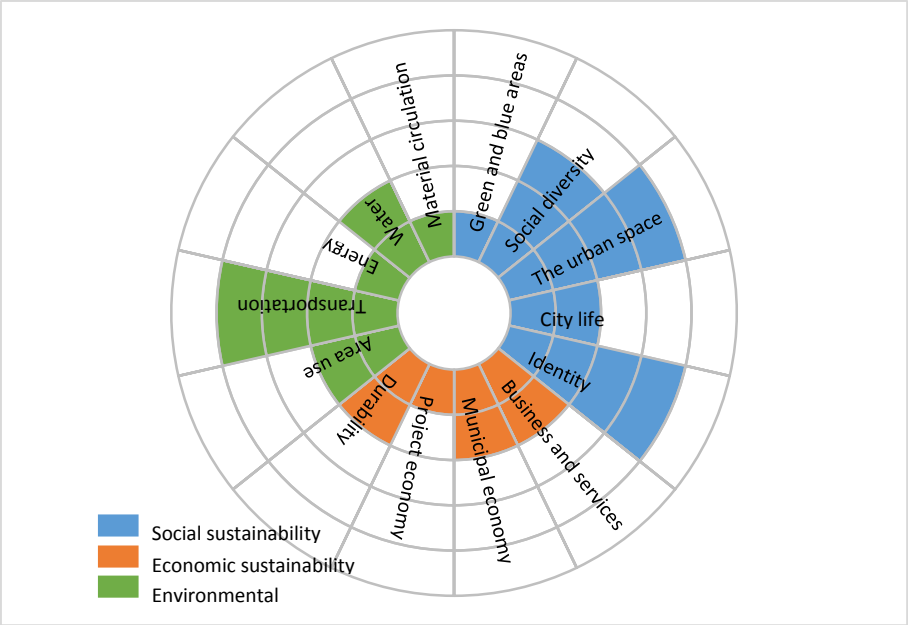

Figure 3.5 - The Sustainability Tool of Copenhagen. Author's work (based on City of Copenhagen n.d.)

The documents used were public. They were created by the stakeholders involved in the process for either one or more of the following purposes: describing, clarifying and communicating their goals and responsibilities, as well as the actions taken to achieve them. Some of the documents (as well as the legal documents and some of the online media sources) are only available in Danish, however the researcher is fluent in Danish so this did not pose a problem for the data collection.

The goal with reviewing the planning documents was to identify the goals and responsibilities of the different stakeholders, and the tools and actions available for these stakeholders in the development process at North Harbour. During the review, the goals and responsibilities of stakeholders were identified and the interconnections between them were investigated in order to understand the different goals and responsibilities as well as the actions and tools used by the stakeholders for addressing them, and the possible synergies and conflicts between them. The goals and responsibilities were sorted based on the stakeholders as well as their content in order to identify commonalities and differences. The data resulting from the review was then used as the basis of the game created as part of this project.

Legal documents

Besides planning documents, legal documents about planning in Denmark as well as the North Harbour area and CPH City and Port Development were reviewed as sources about the development process that could clarify some of the goals and limitations of the stakeholders. These were especially the Planning Law (Consolidation Act nr. 587, 2013) and the law about the establishment of CPH City and Port Development (Law nr. 551, 2007).

Online media

Online sources were used for collecting background information about the development of the North Harbour. One specific example is the use of the websites of development and investor companies involved in the North Harbour area, as well as the list of these companies that was retrieved from the

home page of the North Harbour area (CPH City and Port Development, n.d. C). The websites of the two relevant planning courses at Aalborg University were also utilized (Aalborg University, n.d. A, B).

3.2.2 Collection of primary data

Primary data was collected in this research as an aid for understanding the background of the development process in the North Harbour. It also served the purpose of gathering data about the learning of the participants of the gameplay sessions that provides the basis for the analysis in this research. A combination of qualitative and quantitative approaches was used in this respect, with the purpose of arriving at a well-rounded research into the phenomenon of game-based learning (cf. Mayer et al. 2014).

Site visits

The site of the development at the North Harbour was visited multiple times in order to collect visual data and notes which were used as information for the game, and to contact relevant persons from CPH City and Port Development for interviews and further information about the development. The visual data was recorded in the form of still images with a smartphone device.

Interviews

Narrative interviews (Bryman 2008) were used for gathering general information about the development process in North Harbour, or more specific information relating to one or more of the stakeholders of the development. They were also used as a data collection tool about the creation and use of serious games in urban planning.

Interviewees

Planning professionals working at the City of Copenhagen and CPH City and Port Development were contacted via e-mail and were chosen for their insight into the development process at the North Harbour. Researchers and professionals were contacted in person as well as through e-mail. The following interviews were conducted as part of the data collection:

- Patrick Driscoll, Aalborg University – Main topic: North Harbour, planning games (Appendix J)
- Silvia Dragomir – Main topic: North Harbour, planning games (Appendix K)
- Rita Justesen, CPH City and Port Development, head of planning and architecture – Main topic: North Harbour (Appendix L)

These interviews were used for obtaining practical and theoretical knowledge, as well as insights about the use of serious games in educational and planning settings. The interviews were also used as a means to find further sources and further possible interviewees.

Recording and transcription

The interviews were recorded using a digital audio-recorder. The interviews were not transcribed in their entirety. They were subject to a preliminary coding and segments with no information relating to the topics of interest about the development or serious games were not transcribed. These segments are noted in the transcripts, with the addition of a brief summary of their contents.

Pilot testing sessions

The testing sessions were part of the game design process, and they served to ensure playability of the game and its usefulness as a learning tool. There were two types of tests: some testing sessions were run by the Medialogy students creating the game as part of their semester project in November and December 2014. From late December 2014, some of the testing sessions were run together with the researcher, and were aimed at further refining the gameplay and the game's representation of reality in order to ensure its usefulness as a learning tool in the field of urban planning. Tests were run with planners at CPH City & Port Development, with fellow students, with professionals who work with serious games, and with experts and PhD students in the field of planning from Aalborg University Copenhagen. During these tests, the data collection in relation to the quality of the game was more informal and was based on an audio recording of the session or notes taken by the researcher. These notes served as feedback about the game and were only used for refining that.

Questionnaires

Questionnaires were used for gathering data in relation to game-based learning in this research. This includes demographic data and background data about the participants and their experience with planning and games, as well as themeasured and self-assessed learning of participants before and after the gameplay sessions.

In order to simplify the analysis of the questionnaire results, the questionnaires were created online using SurveyXact as web-based questionnaires allow for easy extraction of data (Maxwell 2009). Where possible, participants were asked to fill in the questionnaire online. In cases where this was not possible, a print-out of the questionnaire was filled out and the answers were digitalized by the researcher afterwards. SurveyXact was used because it provides easy transferability of the data to NVivo, where coding of the data was done. The questionnaires are attached to this report under Appendix A, B and C. Care was taken to include a means of identification in all of the questionnaires, based on which it was possible to track the participants through the various stages of data collection. E-mail addresses were used as identification, which were excluded from this report and replaced by an alternative form of identification in order to protect participant anonymity (see Ethical considerations).

Questionnaire 1 (Appendix A) was distributed to participants prior to the workshops via e-mail, and was used for gathering demographic information about the participants in order to clarify characteristics of the study population. It also included questions in relation to the experience of participants with the field of planning, and their preferences in relation to games and learning. The statements used to determine preferred learning styles of the participants were adapted from Bekebrede et al. (2011). They provide the question, the multiple-choice answers and explain the method of evaluation of the answers as well. **Questionnaire 2** (Appendix B), distributed prior to the gameplay but after the presentation about the development process and the game, focused on the self-assessed and measured cognitive knowledge of participants, as well as information about whether or not they had previous familiarity with the game (read the rules). The results provided the baseline for the assessment of cognitive learning. For this questionnaire, as well as for Questionnaire 3, different versions were created for the different roles. This differentiation was necessary because the different roles show significant dissimilarities in terms of gameplay and goals. **Questionnaire 3** (Appendix C)

focused on the post-game self-assessed and measured cognitive knowledge of the participants. It also included questions about the gameplay experience and a call for further comments about the game.

The design of the questionnaires

The topics and specific questions included in the questionnaires were informed by the state of the art of serious games and game-based learning (cf. Chapter 2.2). The research questions and the purpose and design of the game also influenced the design of the questionnaires. For example, the two different groups of roles – the planners and the consultants, cf. Chapter 4.2– experience the game from significantly different perspectives. Therefore, players received questionnaires tailored to the role they were assigned in the gameplay session.

Additionally, general considerations about questionnaire design were taken into account, following the recommendations of Bryman (2008). These include the use of simple wording and sentence structure to avoid misunderstandings. Double questions and questions that include negatives were avoided, and care was taken to ensure that questions that needed to be answered on a scale followed the same structure, in order to avoid mistakes on behalf of the respondents. The questionnaires included a combination of open-ended and closed questions. In the case of closed questions, care was taken to provide a balanced set of answers that relate to the question, as well as to include a "don't know" or "not sure" option, in order not to force people into expressing opinions they do not hold (Bryman 2008).

Observation

During the gameplay sessions, the conversations of participants were recorded using a digital audio recorder. Each of the three sessions were recorded separately, and each session was recorded in two parts: Stage 1 was recorded starting from the pre-game discussions to the end of the mid-game discussion, and Stage 2 was recorded from the start of the gameplay to the end of the end-game scoring. The data collection methods did not disrupt the gameplay significantly.

These audio recordings were used as the basis of observational data collection about participant behaviour. The method was based the recommendations of Bryman (2008). It can be classified as **contrived observation**, as the observer facilitated the gameplay session with the specific aim of observing its effects on the behaviour of the participants. The observation followed a **structured** design, as the type of behaviour of interest was very specific. The selection of noted behaviour was based on a **behaviour sampling** method, where interactions among the participants and between the participants and the facilitator or assistant were noted based on the audio recording, mainly in relation to actions, roles and goals. As the observed behaviour is specified in one category (participant interaction in relation to the above topics), no specific observation schedule was created. In some cases, the notes were supported by transcribed quotes from the conversations, to underline especially interesting or typical behaviours. The resulting notes can be found in Appendix D. The method of observation was principally **non-participant**, however there was interaction between the observer and the participants as the observer was also the workshop facilitator.

The observational data was used for analysing the nature of participant interactions, as well as for investigating whether patterns can be found in the changes of participant behaviour during the course of the gameplay sessions. The participants were possible to identify by their voices and references to

the roles they played, and in the observational notes they are identified by the code assigned to them (see Ethical considerations).

Research diary

A research diary was kept throughout the course of the research, starting from the 28th August until the end of the game-play sessions in February 2015. During this period, entries were made weekly, and they serve as a record of important decisions, changes made and milestones reached during the research project. This research diary is available as Appendix M of this report. While the research diary did not follow the entire course of the research, it was still beneficial in providing a means of reflection about the changes in the research design, and it also improves the transparency of the research, which is helpful for improving the reliability of the research (Yin 2009).

A personal research diary was also kept, with notes and memos about the research. The relevant entries were used in the research and as notes for the written report and the development of the game.

3.3 Significance

This case study extends on the existing research into planning games used as learning tools. It combines the aspects of educational and planning games, creating a master planning game with the specific purpose of being used by future planning professionals to learn about the different social and economic goals of the stakeholders in a sustainable urban development process, and come up with strategies to achieve them in the context of the game. Therefore, it addresses the need of preparing planners for managing such development processes, and attempts to confirm the proposition that the games are useful not only for skill development in negotiation processes (which they are commonly used for), but also as tools for facilitating cognitive learning in this context. Furthermore, it addresses the need expressed in the literature for systematic assessment of game-based learning, by seeking empirical evidence for the claims in the literature about the positive effect of games on verbal knowledge and the learning process. The game created as part of the research serves a practical purpose as a learning tool, which can be used in planning education.

3.4 Limitations

Certain aspects of the design process were complicated by the fact that the students primarily in charge of game design did not have prior knowledge of the field of urban planning. The time available for them to understand the field and the process was also significantly limited by the timeline of the student projects. Therefore, it was decided early on in the process that an in-depth analysis of the development process and the context was not possible. Instead, available tools used in the development would be used. The most influential of these tools were the Sustainability Tool (The Urban Design Centre, n.d.) and the North Harbour development strategies (CPH City and Port Development 2009; 2012).

Participation in the workshops was voluntary. Therefore, it is likely that the students who decided to participate have a specific interest in games and game-based learning. This might influence the outcome of the research by including an inherent bias. The game that was used in the workshops was created by a group including the researcher. Therefore, it is possible that the researcher, who also facilitates the gameplay sessions, had an influence on the outcome of the sessions by having a bias towards the learning technique – the consideration of this bias is promoted by Gosen and Washbush (2004).

The design of the questionnaires changed between the two workshops, allowing the researcher to learn from the mistakes made during the preparation for the first workshop. While this was beneficial for the learning process of the researcher and possibly for the results of the second round of data collection, it might affect the outcome of the research.

3.5 Validity and reliability considerations

Yin (2009) identifies four aspects that define the quality of the case study: construct validity, internal validity, external validity and reliability. The following sections follow his definitions when explaining how these various aspects were addressed.

Addressing **construct validity** was done by utilizing two tactics: carefully defining the specific changes in knowledge that the researcher was interested in, and by reviewing relevant research in the field to find tools that can provide information about these changes in knowledge. Additionally, evidence was collected from multiple sources where it was possible. **Internal validity** was addressed by utilizing a pattern matching analytical approach. **External validity** was considered by basing the generalizations of the findings of this case study on the interpretation of the results in light of the state of the art, ensuring that the conclusions drawn are supported by a broader view than the limited scope of the single case study.

Yin (2009) describes **reliability** of the case study as ensuring that the procedures in the case study can be repeated by another researcher: basically documenting as much of the research process as possible. In order to address the question of reliability, I aimed for "recoverability" of the research as opposed to "repeatability". This involved creating a detailed research design in advance, and writing a research diary that highlighted the most important changes in the design. The methodology of the research project was established and declared in advance of carrying out the research. This does not mean, however, that the methodology was treated in a non-flexible way, as it is important that the research design allows for a reflexive research method, where data recovered along the way might alter the design. The main changes between the proposed and final design are highlighted in the research diary.

3.6 Ethical considerations

The interviewees and participants of the workshops were sent an e-mail prior to the conduction of the interview, which introduced the researcher, stated the purpose of the research, the means of data collection during the sessions and addressed questions of confidentiality and anonymity. This e-mail resembled the Letter of Introduction as defined by Yin (2009), but it consisted of a base e-mail providing personal and contact information as well as information about the goal of the interview, while an attached file contained the brief description of the project.

The participants of the workshops were not represented by their name or referred to their persons directly in any way in this report. However, the data collected *ex-ante*, during the interventions and *ex-post* from each participants needed to be linked to each other in order to allow for discovering connections between the different variables in the research and thus enable more in-depth analysis of the collected data. In order to do this, all participants were assigned a number that they were identified by in this report and its appendices. All interviewees were offered the option to remain anonymous, but none decided to do so. The participants in the workshops were assigned a sign that contained a letter indicating their role (C for consultants and P for planners), and a number between 01 and 10. This sign identifies them in the report.

4 The case

This chapter presents the case that is investigated in this report in order to understand the way games affect the cognitive learning of planning students in relation to the conflicting social and economic goals in sustainable urban development processes. First, the game is introduced. Since the purpose of the game was to introduce planning students to the complexity of the social and economic aspects of sustainable urban development processes, using the example of the North Harbour, the chapter begins with introducing the area and the process of developing a new, sustainable urban district there. This is followed by a discussion of the stakeholders, interests and goals involved in the process. The main stakeholders identified are the Danish State, the City of Copenhagen, the developers and investors and the public. The chapter then moves on to introduce the game: starting with the way it models the development process, and continuing with the rules and limitations of interaction within the boundaries of the game. Finally, Aalborg University is introduced as the site of the case study, with its main educational approach of problem-based learning, and a brief introduction of the MSc programmes in planning that the workshop participants were enrolled in.

4.1 The development process in the North Harbour

The North Harbour is located close to the centre of Copenhagen, Denmark. It is a former and current industrial harbour that is currently being turned into a lively urban district with a variety of different functions. As such, it is presented by Copenhagen City and Port Development as symbolic of the city's transformation from industrial to knowledge economy (CPH City and Port Development 2009; 2012). The area of North Harbour was created using rubble and earth excavated in other parts of Copenhagen, gradually extending over the past. In 2009, about half of the North Harbour still housed harbour-related functions, with the other half being out of use (CPH City and Port Development 2009; 2012).

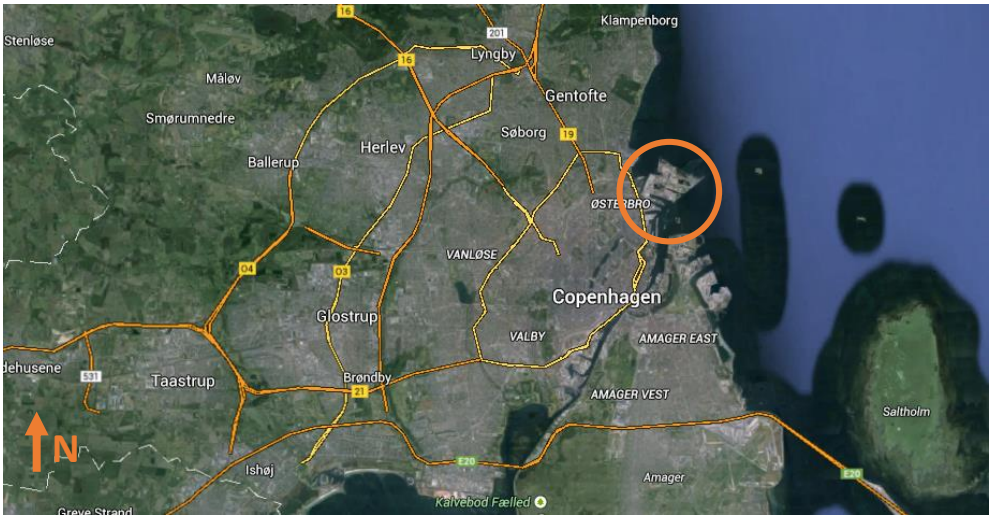

Image 4.1 – Satellite image of Copenhagen with the North Harbour. Source: http://maps.google.com - markings made by Author

The development of new urban and especially residential areas is necessary in Copenhagen, since according to projections, the City of Copenhagen, with a population of about 534 000 in 2014, is expected to have a large influx of new inhabitants in the following years (Statistics Denmark 2014; CPH City and Port Development 2012). Therefore, new urban areas, housing both residents and workplaces, need to

be established. One of these new, planned areas is in the North Harbour. The City of Copenhagen and the Danish government agreed on the principles governing the development in 2005, and the legislative background was laid in 2007 (CPH City and Port Development 2009). By 2012, the strategy for the first stage of the development was published, and by 2014, construction has started in the area closest to the centre.

In 2007, the development company CPH City and Port Development was created and put in charge of the new large-scale urban development projects, such as Ørestad and harbour areas in Copenhagen, including the North Harbour (CPH City and Port Development, n.d., A; law nr. 551, 2007). It was agreed upon that the main direction of the development and the structure for the new city district would be decided through an open international ideas competition. The goal of the competition was to design "the sustainable city of the future" (CPH City and Port Development 2012, p. 9). The competition took place between May 2008 and March 2009. The winner entry was then further developed by CPH City and Port Development and the City of Copenhagen, resulting in an overall development strategy for the entire North Harbour area. Spatially, the strategy is characterized by the creation of islets and canals (see Image 4.2).

Image 4.2 - The structure plan for North Harbour (CPH City and Port Development 2009, p. 18)

According to the strategy, the overall area of the North Harbour is going to house about 40.000 inhabitants and 40.000 workplaces on 3.5 million square metres (CPH City and Port Development 2012), so it was important that the process be broken down into stages. The first stage consists of developing the Inner North Harbour district, which is divided into smaller areas still. The first area to be developed is the Århusgade Quarter, where construction began in 2012 and is currently ongoing (CPH City and Port Development 2012). This first stage is expected to establish up to 400.000 square metres of new floor area, and preserve further 70.000 square metres of floor area in existing buildings (CPH City and Port Development 2012). According to the strategy, the Århusgade Quarter will have about 3000 residents and approximately 6-7000 workplaces.

The areas to be developed in the near future are the different sections of Inner North Harbour. Additionally, in the autumn of 2014, the legislative background was also created for the future development of Levantkaj, with the possibility to build 500.000 square metres of floor space (cf. Appendix L). The rest of the North Harbour is classified as a "perspective area" in the Municipal Plan of Copenhagen (City of Copenhagen 2012).

Image 4.3 – The Århusgade Quarter (CPH City and Port Development n.d., pp. 13-14) – markings made by Author

Functionally, the area shows diversity. By November 2014, 19 of the 32 plots in the Århusgade Quarter have been sold. Out of the 19, 5 plots will be used for commercial purposes, 7 will host a mixture of commercial and residential functions, and 7 will be entirely used as residential buildings. The mixed-function buildings are primarily residential, with a requirement to place commercial, cultural, or public functions on the ground floor. Furthermore, 1 plot is reserved for a parking house, and another is under option for social housing. The remaining plots are expected to host commercial functions (CPH City and Port Development, n.d. C). Outside the Århusgade Quarter, only a small number of plots have been sold so far. Copenhagen International School owns 1 plot in Levantkaj West, where they plan to build their new campus. In Sundmollen, 1 plot has been sold for primarily residential purposes (CPH City and Port Development, n.d. C).

4.1.1 Regulating the development of the North Harbour

There are numerous documents affecting the direction of urban development in central Copenhagen, and specifically in the North Harbour. Together, these documents create the overall framework that guides the development and planning process from the regional, through the urban, to the individual buildings' architectural level. In this section, these are briefly introduced. The relevant contents of the documents are discussed later, when the goals and interests of different stakeholders are explained.

The legal framework regulating the planning and development of the North Harbour can be found in planning regulations on different levels. These include the Fingerplan (Danish Nature Agency 2013), the spatial strategy for the Greater Copenhagen Area, the attachment about the North Harbour to the Municipal Plan for the City of Copenhagen (The Urban Development Centre 2013), and the Local Plans for areas in the North Harbour (e.g. City of Copenhagen 2011).

In accordance with the legal framework, Copenhagen City and Port Development have created their strategies about the North Harbour, published throughout the development process. The most important publications are the Urban Strategy for the North Harbour (CPH City and Port Development, 2009) and the detailed strategy for the Inner North Harbour area (CPH City and Port Development 2012).

The Sustainability Tool

Besides the legal and strategic documents, there is another important tool used in the City of Copenhagen in relation to urban development plans. In order to ensure sustainability, all development plans for urban districts are evaluated with the help of the Sustainability Tool of the City of Copenhagen (City of Copenhagen, n.d.; Appendix I) (see Figure 4.1). Copenhagen has a holistic view of sustainability, including environmental, economic and social aspects (City of Copenhagen, n.d.). These different aspects of sustainability are all represented in the Sustainability Tool. The Tool names 14 different topics, categorized under the three aspects. The list of topics and the categorization can be seen in Figure 3.5.

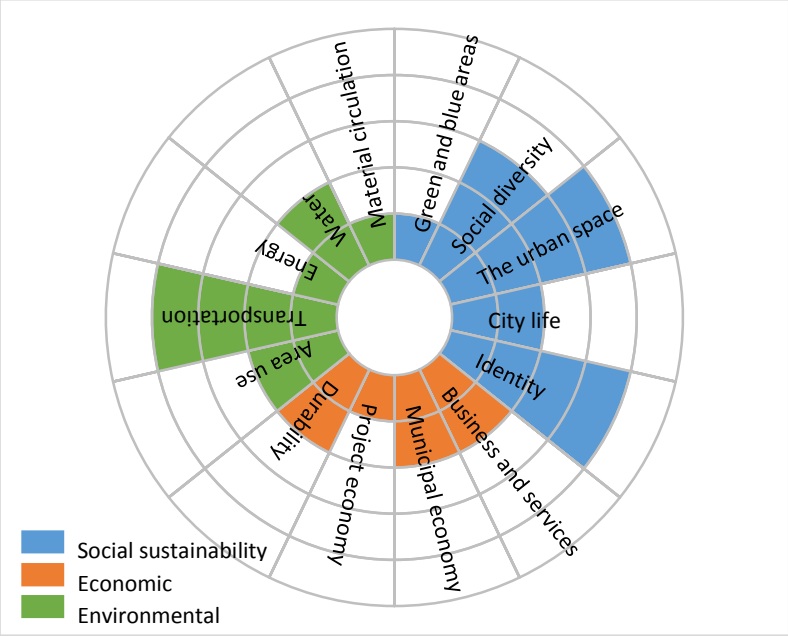

Figure 3.5 - The Sustainability Tool of Copenhagen. Author's work (based on City of Copenhagen, n.d.)

Development plans are evaluated on the specific topics named in the Sustainability Tool with the help of a set of predefined questions, and for each topic the results range from 1-5, with 3 being set as standard and 5 representing best practice (City of Copenhagen, n.d.). For example, in order to ensure that the new district meets the standard of social sustainability, the plans have to address the topics of green and blue areas, social diversity, urban space, city life, and identity. Assessment is aided by

supporting questions for each topic, such as "*How are the area's natural elements strengthened?*" and examples for possible answers are provided as well (The Urban Design Centre, n.d.).

4.1.2 Stakeholders and interests in the development process

The first step in modelling the development process was the identification of the most important stakeholders. The stakeholders listed here were selected based on their influence on the outcome of the development, the realized urban district in the North Harbour. They are grouped together based on their input and control over the development process. The following figure shows the stakeholder groups.

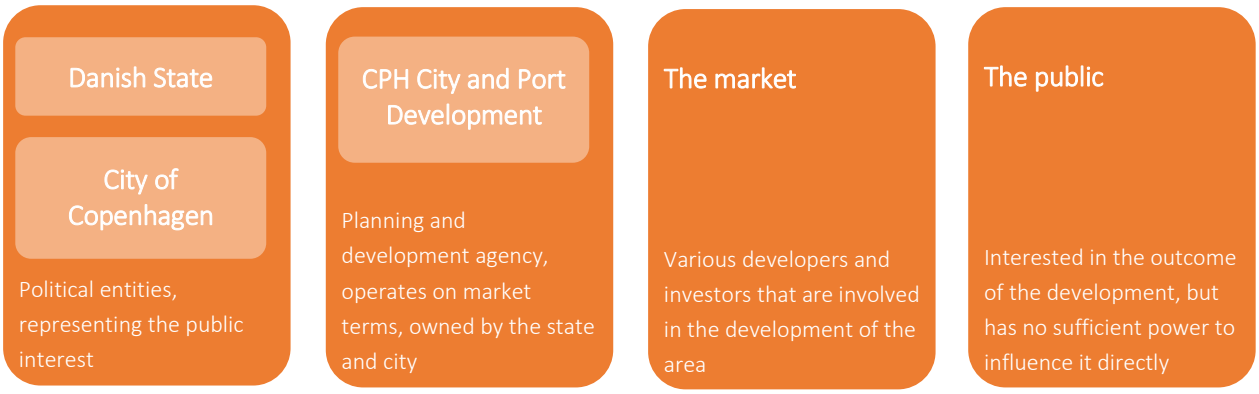

Figure 4.1 - Stakeholder groups in the development process

In the following sections, the stakeholder groups are introduced in some detail. Under each stakeholder group, their most defining relevant characteristics, such as their terms of operation and focus in the development of North Harbour are discussed.

The Danish State and the City of Copenhagen

In the analysis of the development process, the Danish State and the City of Copenhagen were considered as one group. According to the planning regulation in Denmark, both the state and the city are involved in creating legislation that regulates urban development (Consolidation Act nr. 587, 2013). Additionally, since the Danish state and the City of Copenhagen jointly own CPH City and Port Development (Law nr. 551, 2007), both entities are involved in the developments carried out by it.

The State and the City of Copenhagen share many characteristics. In relation to urban development, the planning system in Denmark requires that the local plans be synchronized with the Municipal plans, which are in turn in accordance to the regional and national plans (Consolidation Act nr. 587, 2013). This means that the urban development goals between City and State have to be synchronised. In this sense, it is possible to treat the state and the City of Copenhagen as expressing the same goals and interests in the case a local development process such as the one at North Harbour.

When discussing planning in the public sphere in general, ideally planning can be expected to serve long-term interests of society, but it is also commonly accepted that this might be influenced by relatively short-term political interests (Fainstein & Campbell 2003).

Copenhagen City and Port Development

As mentioned before, CPH City and Port Development was created and put in charge of the redevelopment of urban areas in Copenhagen in 2007. Originally, the development company was called

Arealudviklingsselskabet I/S – which can be translated as Land Development Company – (Law nr. 551, 2007), and later changed its name to CPH City and Port Development. The development company is jointly owned by the State of Denmark (45% originally, now 5%) and the City of Copenhagen (55% originally, now 95%) (CPH City and Port Development, n.d. A; Law nr. 551, 2007). CPH City and Port Development owns the land in the North Harbour as well as in other harbour and development areas in Copenhagen, and the income secured by the development of this area has to finance a large part of the construction of the Cityring metro-line in Copenhagen (The Urban Development Centre 2013).

The background of the establishment and the ownership of Copenhagen City and Port Development has important implications for the way it functions. The majority of the leadership of the company consists of representatives from both the Danish state and the City of Copenhagen (CPH City and Port Development, n.d. A, Appendix L). This means that these entities have a strong influence on the operations of the development company. On the other hand, CPH City and Port Development is a company that has to develop and sell the land in the North Harbour, operating on market terms (Law nr. 551, 2007). In order to fulfil their financial obligations in relation to the Cityring metro line, they need to ensure sufficient income from developing and selling the land.

Therefore, it is important for them that they create an attractive district in North Harbour, not only because that correlates with the goals of the City of Copenhagen, but also because they are interested in securing developers that will buy the land in the area (cf. Appendix L). If the area is not expected to be attractive, then developers will not be interested in building there, which means that CPH City and Port Development will not be able to secure the income they expected. This economic pressure can lead to a difference in priorities between the City of Copenhagen and CPH City and Port Development. This means that CPH City and Port Development can end up in a peculiar position, having to balance their economic needs with the social and other expectations of the City of Copenhagen and the Danish State.

Developers and investors

The developers and investors who have bought the plots in the Århusgade Quarter show great diversity (cf. Appendix M). The largest group consists of those interested in residential development. Among them, a range of different types can be found: some developers have a strong focus on luxury apartments (e.g. Walls, see http://wallscopenhagen.dk/), while others find it important to provide a comfortable and green experience in the city centre (e.g Tetris, see http://www.tetris.as/). Affordable housing is also referred to in this respect (Kuben Byg, see http://kubenbyg.dk/). The developers and investors are also diverse in terms of ownership: there are pension funds (e.g. AP Pension, see http://www.appension.dk), private companies (e.g. NCC, see http://www.ncc.dk/), individuals, and companies that specialize in public-private partnerships (e.g. CASA A/S, see http://www.casa-as.dk/).

Generally, they operate on market terms. They are not public entities, and they represent their own or their clients' economic interests first and foremost. This shows a clear contrast compared to the operation of the stakeholders discussed above.

The public

Involvement of the public in the planning process is an important part of planning regulation and practice in Denmark (Consolidation Act nr. 587, 2013). The North Harbour development also included public hearings and a dialogue with citizens of Copenhagen and other stakeholders (CPH City and Port

Development 2009; 2012). The dialogue began before the ideas competition and continued through the planning process. Additionally, the public also has to be considered as the prior, current and future users of the development area. However, they do not represent the type of direct and organized power in the development process as the previously discussed stakeholders (Appendix J).

Now that the stakeholders in the development process have been introduced, it is possible to take a closer look at the specific goals they are working towards in the North Harbour.

Goals of influential stakeholders in the development process

In the following sections, the goals of the different stakeholder groups in the process are explained. These goals were identified based on legal documents regulating the development, and statements made by the different stakeholders in publications as well as in interviews with the stakeholders. The identification process did not involve a critical in-depth analysis of the statements. According to the focus of the game, the goals discussed are limited to the social and economic aspects of the development.

The goals of the public are not investigated, as they are not considered as a homogenous group with a clear goal or direct power to influence the development process. This leaves the following stakeholder groups: the Danish State and the City of Copenhagen; CPH City and Port Development; and the investors and developers. The following sections detail their goals in the development process.

The Danish State and the City of Copenhagen

The Danish State and the City of Copenhagen are political entities representing the public interest in Denmark and in Copenhagen.

As it has been said repeatedly, sustainability in a holistic sense is an important concern for the City and the State. The City of Copenhagen uses the Sustainability Tool to assess the qualities of urban development plans. The social and economic aspects of sustainability can be listed from the Sustainability Tool:

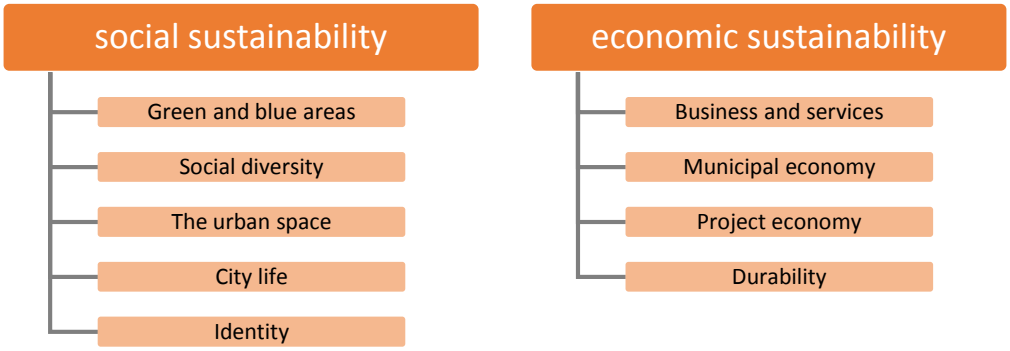

Figure 4.2 - The social and economic aspects of the Sustainability Tool (City of Copenhagen, n.d.; Appendix I)

In terms of socially related goals, in accordance with the Sustainability Tool, it is an overall expectation expressed in the local plans that the ground floor of the buildings is used for public functions, that there is a mix of functions in the district in general, and that there are large green areas within walking distance from residential buildings. The local plan furthermore addresses a specific goal in relation to social sustainability, more precisely of diversity, and that is the requirement of 20% small apartments in each of the smaller districts of the North Harbour. Additionally, the City of Copenhagen expresses a

strong preference for establishing social housing in 20% of all residential buildings in new urban districts (cf. Appendix L). This request is not part of the local plan, but it is a strongly pressed wish of the City. In order to ensure that certain functions are present in the district, the City of Copenhagen has option on the land for the establishment social and communal functions, such as day-care centres and social housing blocks.

Turning to more economic questions, Fingerplan 2013 (Danish Nature Agency 2013), which regulates land use in the Copenhagen Metropolitan Area, also has regulations that are relevant for the North Harbour development. It allows large office buildings to be placed feely in a 600-metre radius from stations. Since this presents an opportunity to create office-districts surrounding the metro-stations in North Harbour once the Cityring metro-line is built, it also influences the goals of CPH City and Port Development.

Finally, the City expresses architectural and visual expectations for the development as well. The Local Plan for the Århusgade Quarter (City of Copenhagen 2011) also specifies some of the expectations about the architectural qualities for the development. The height of the buildings is expected to be between three and six storeys, and exhibit a varied nature within the blocks. The maximum building height is 20 metres, which corresponds to six storeys, but there is a possibility for individual buildings to be taller. There is an expectation for placing publicly used functions on the ground floor, which, aside from ensuring a mixture of public and private functions in the area, can also create a lively environment.

Copenhagen City and Port Development

Looking at the goals of CPH City and Port Development, the picture is just as diverse. The dual nature of the development company, existing between market regulations and public and political entities, means that they have to attend to the needs and requirements of both.

If one looks at the values that the development process is stated to be guided by, the result is somewhat blurry. Different statements are made as to what the values are, and the overall strategy and the detailed strategy for smaller areas also contain different goals in this respect. The original vision listed the following characteristics: *an environmentally friendly city; a vibrant city; a city for everyone; a city by the water; a dynamic city; a city with green traffic* (CPH City and Port Development 2012, p11.). The winning proposal then lists the following aspects as central for the direction of development: *CO2 friendly city; islets and canals; five-minute city; blue and green city; smart grid; identity and history* (CPH City and Port Development 2012, p14.). Moving forward, the development strategy for the Århusgade Quarter, the first area to be constructed, also has its own list of goals: *a sustainable district; a waterfront district; a district with contrasts; an active district; a compact district* (CPH City and Port Development 2012, p2). The comparison of the three sets of goals can be seen in Figure 4.4.

Figure 4.3 - Values of the development process sorted by the different stages of planning (CPH City and Port Development 2009, 2012)

As the focus in this research is on the social and economic aspects of the development process, it is useful to narrow down these values to those that coincide with the social and economic aspects of the Sustainability Tool of the City of Copenhagen (See Figure 3.5). The resulting set of values can be seen in Figure 4.5.

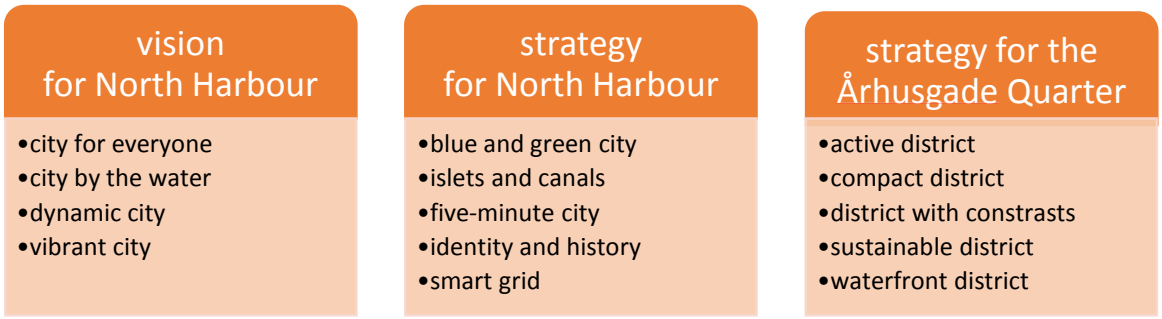

Figure 4.4 – Social and economic values of the development process sorted by the different stages of planning (CPH City and Port Development 2009, 2012)

Turning to the numerical goals of the development process, the proposed time-scale for the creation of a new urban district in the North Harbour is about 40-50 years (CPH City and Port Development 2009). During this time up to 4 million square metres floor area is expected to be established, with a mixture of different functions such as residential, cultural, recreational, commercial, etc. The district will house about 40 000 residents and as many workplaces (CPH City and Port Development 2009). However, the process is broken down into smaller stages, in which smaller areas are developed more or less one at a time. Each of these areas are treated individually, so they have their own characters. It has already been discussed that the aim is to have a good balance of different functions in each of this areas, resulting in 40% residential and 40% commercial buildings, with 20% allowed as mixed-function, providing some flexibility in the development.

Developers and investors

There are no documents clarifying the goals of the developers and investors, nor would it be possible to create such a document due to the large variety of entities involved. However, from publicly available information from their websites (see Appendix N), these companies and individuals apparently share the goals of other entities that operate on the terms of the market. Many of them claim to focus solely

on the return of investment (e.g. KPC, see http://www.kpc.dk), but there are also companies with a strong interest in sustainable design (e.g. NCC, see http://www.ncc.dk/).

External forces in the development

The larger-scale social and economic environment are considered as external forces in the development process. Such forces are, for example, the state of the Danish and world-economy, or the state of the market in terms of demanded building functions (e.g. residential or office buildings) (cf. Appendix L). These factors determine, for example, the price and rate at which various functions: apartments or office buildings can be sold, which influence the stakeholders who operate on market terms. The stakeholders do not have direct influence on these factors, but the stakeholders and development process, and therefore its overall outcome is influenced by them.

After introducing the development at the North Harbour, the chapter now turns to discussing the game, and the way it relates to the above process and the stakeholders and goals involved in it.

4.2 The game

The game that is created as part of this project attempts to facilitate cognitive learning in relation to the social and economic goals related to sustainable urban development that the abovementioned stakeholders have in the development process of the North Harbour, as well as the conflicts and possible synergies between these goals. Instead of providing ready answers, the players have to achieve certain stakeholder goals in the game in order to win, but it is up to them to explore and experiment, and see what strategies give good results.

Image 4.4 - Game in progress

Modelling the development process in the game

The following characteristics of the development process were considered crucial and were therefore implemented into the model of the game: the stakeholders identified as influential and powerful in the process and their relationships; the difference between stakeholders in terms of guiding principles, goals, and scale of influence on the process and outcome; the goals of functional and social diversity; the

division of the development process into smaller stages both geographically and time-wise. The resulting model can be seen in Figure 4.6.

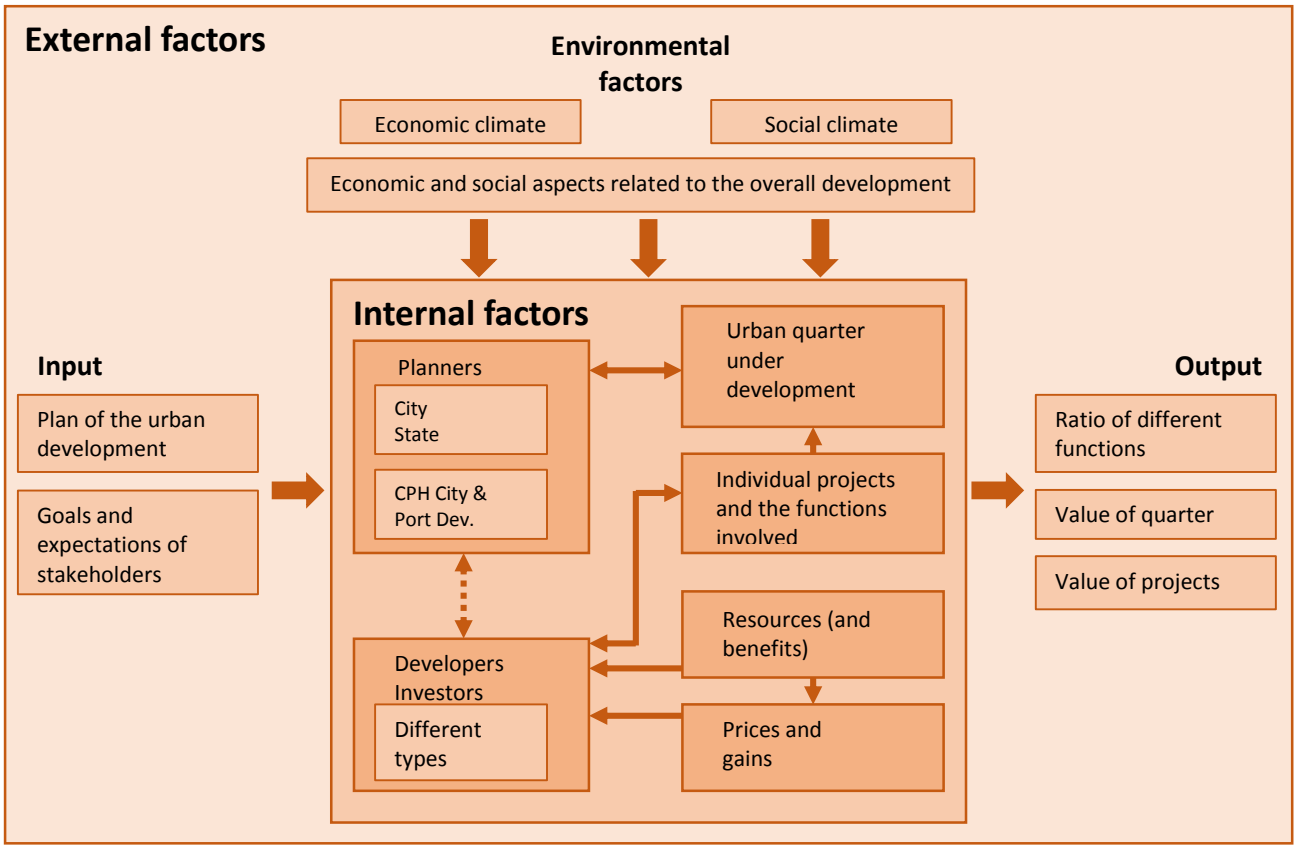

Figure 4.5 – The model of the development process (based on Harteveld 2011)

The figure above demonstrates the model that serves as the basis for the game. The factors considered were sorted into external and internal factors, indicating the level of influence on the model. The factors represent a combination of stakeholders, physical aspects and other determining factors in the process of the urban development. The arrows indicate relations of influence and their directions. The dotted arrow between the planners and developers express the concept that the two groups of actors have the capability to influence each other, however this influence depends on the individual player's ability to negotiate and realize their interests. They determine the rules of interaction among the players and between the players and the game.

The different parts of the above model are all represented in the game in some form. The input stimulates the internal factors in the model, resulting in the system of interactions and the process that provides the flow of the game. The goals and terms of operation of the different stakeholders, together with the relationship between them helped defining the roles that the players take on in the game, as well as the goals for each of these roles. The most important goals of players in the game are determined by the outputs of the model. The resulting roles can be seen in the following figure:

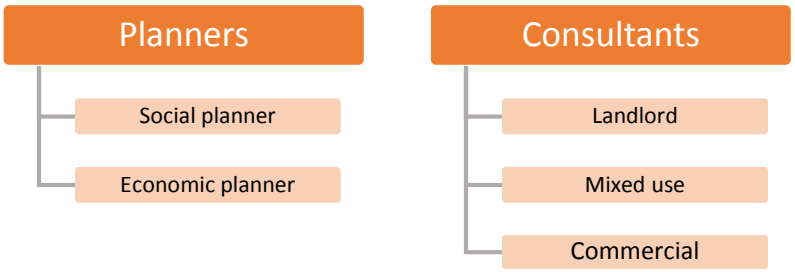

Figure 4.6 - The roles in the game

As it is shown in the figure, the roles belong to the two main groups also seen in the model above: the planners and the developers, the latter represented by *consultants* in the game. There are different subtypes under both of these two groups: the planners focus on either social or economic aspects, while consultants can specialize in creating residential or work environments, or a mixed-use area. The two groups play vastly different roles in the game. Their goals, their interaction with the game and with other players and their influence on the resulting urban district are fundamentally different. The level of influence that each role has on the physical development is also apparent in the model. While consultants are in charge of individual projects, but cannot directly manipulate the overall development, while the planners are in the opposite position. The specializations, however, have much less influence on the game. They merely adjust the specific goals and preferences during the gameplay.

A selection of environmental factors are present in the game and can be evoked through action cards that the players draw each turn. This leads to the players being affected by a random event in relation to the environmental factors that influences their actions for one turn. For example, a decrease in interest in housing may force a consultant to pay an increased price for building apartments.

The process, and thus the gameplay, is determined by the actions available to the stakeholders, and by the ways in which the stakeholders and their actions are influenced by other factors in the model. This results in the basic structure of the game that can be described in the following way. The consultants buy structures and arrange them in their projects. The choice and arrangement of structures is determined by, among other things, the specialization of the consultant, the funds available to them, the price of the structure, the resources and benefits provided by each structure, restrictions of height, the position of their project on the board and relative to other projects, and random events triggered by action cards. The planners on the other hand arrange the projects on the board as determined by their specialization, the projects present on the board in terms of both their contents and their positions, and random events triggered by action cards. The game is turn-based, and after each turn, each player has to evaluate the results of the turn and receive rewards. There is no end-game condition, instead, after 10 rounds of play each player is evaluated based on their individual goals.

When creating the game, no optimal strategy was provided, and no certain way to win the game is known to the creators. Different strategies might prove efficient within the boundaries provided by the rules. Each player's actions influence the overall outcome, which means that the different strategies adopted by the players in any session all have an influence on what strategy will lead to victory. This enables the players to explore strategies and experiment more freely in the game. Similarly, it is not predetermined whether players cooperate or compete with each other in order to achieve their goals. This decision is up to the players in each of the sessions, and can even vary during the course of a single session.

In the following sections, the game is introduced in more detail. First, the structure that regulates the gameplay is explored, then the different roles are more thoroughly discussed. The main rules of interaction within the game are also explained.

The structure of the game

Similar to the development process, there are many different elements that together create the game. The physical structure and the organisation of the gameplay are the most definitive in this field therefore these are clarified in this section.

Physical structure

The main framework of the game consists of a game board, a number of project sections, and various structures, such as buildings and parks. A more detailed description of these elements can be found in the Rulebook of the game (see Appendix G).

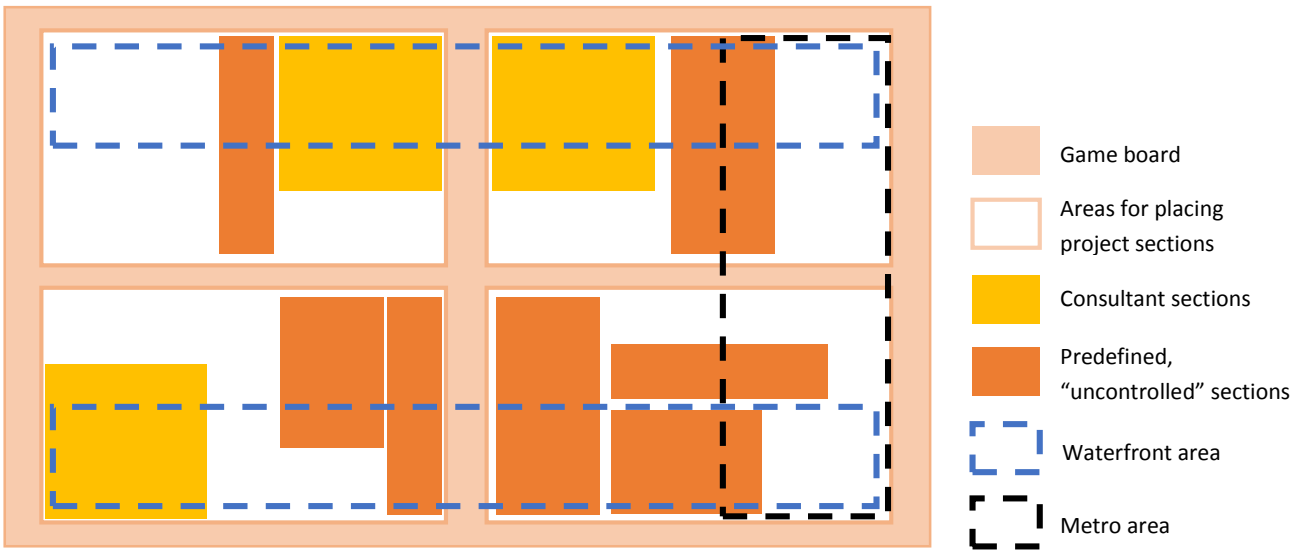

Figure 4.7 - The game board and most important elements

Game board

The game board represents a district of the North Harbour that is being developed, but it is not determined specifically which district it is. For reference, one can for example look at the Århusgade Quarter, or a part of Levantkaj – a part of the Harbour area that forms the basis of one Local Plan in Copenhagen. The two longer edges of the board are considered waterfront, and one of the shorter edge is adjacent to a metro station. The board is divided into 4 equal parts, which only serve as physical delineations that increase the difficulty of placing the project sections in various formations, and otherwise possess identical characteristics.

Project sections

The project sections represent individual projects that are being developed as a part of the district. These sections vary in shape and size, as well as the in the types of structures they contain. They can be arranged on the game board in a large variety of ways, and the game board does not have to contain all of them at any given time.

There are two distinct types of project sections: consultant sections and uncontrolled sections. Both of these can be moved around on the game board by the players taking on the role of planners. The **consultant sections** are controlled by the individual consultants in the sense that they can determine the types and number of structures built on the sections. However, the consultants cannot decide the placement or orientation of the sections; they only have control over their contents and the arrangement of those contents. These sections have to be on the board at all times during the game. The **uncontrolled sections** contain predetermined structures, which cannot be changed by any of the players. They represent additional projects, and can be added or removed during the game.

Structures

There are fifteen different structures in the game, representing various functions: three different categories of apartments, including social housing; three different types of offices; other commercial buildings, such as malls or night clubs; universities; green areas, including green roofs; and so-called creative areas.

Image 4.5 - View of a consultant section on the game board with various structures inserted during gameplay

The structures are placed by the consultants on the sections they control. The height of most buildings represent two storeys. According to regulations about building height in the North Harbour, this means that it is possible to place three buildings on top of each other, resulting in a height of six storeys. Exceptions are the University and the Mall, which have no height attached to them. They are buildings that stand on their own, and cannot be combined with other buildings. There is no other size attached to structures. The consultant sections are capable of containing nine (three by three) structures, and the only relevant and important measurement here is that each of the structures occupy the same ground area, which means that any structure can occupy any space on the sections.

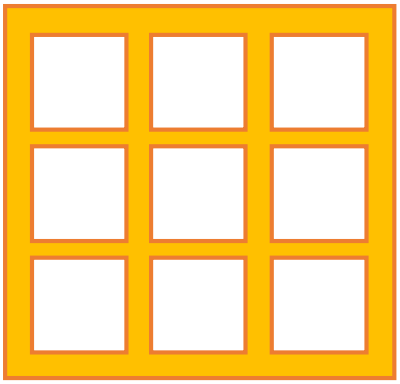

Figure 4.8 - The outline of the consultant sections. The structures are inserted in the white squares.

Structure of gameplay

The game consists of two stages, each of them containing five rounds. After each stage, the consultant sections are evaluated. After the end of the second stage and its evaluation, the final scoring takes place.

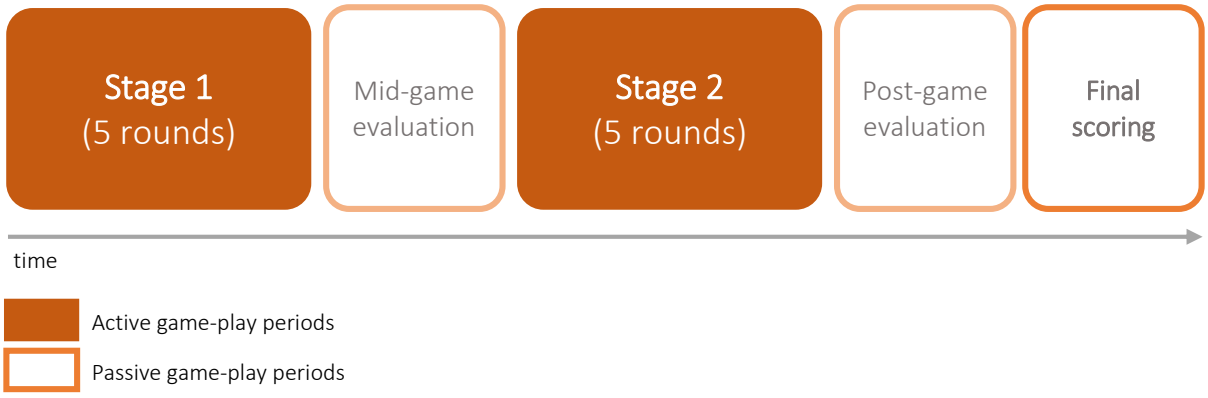

Figure 4.9 - The different phases of gameplay in time

The stages are implemented in the game as a tool to regulate player economy. They do not have a connection to the different stages of the development, as they do not influence gameplay or player interactions. In earlier versions of the game, stages were more representative of development stages, but it resulted in confusion from the side of players, therefore this have been removed from the prototype.

Roles and goals

This section details the different roles in the game, and their relationship to the stakeholders in the development process. First the planner role and its two directions are discussed, and then the section moves on to the consultants and their available options for specialization.

Planners

The planners represent urban planners in the game. They are trying to create an urban district that has a good mix of different functions. This means that they are trying to achieve a balance between residential and commercial functions, as well as make sure that there is sufficient social housing in the area. They make the decisions about the overall layout of the area, creating a master plan through placing different projects on the board and arranging them according to certain limitations. Additionally, they are trying to place certain functions next to each other, in order to raise the value of the resulting district. The planners have to take care that the specific goals set for the development are achieved by the end of the game. This reflects the long-term interests that the public institutions ought to have.

The focus of the planners within these boundaries can be more on the social or more on the economic aspects of the urban development. The two foci are, to some degree, based on planners working at the City of Copenhagen and CPH City and Port Development, respectively.

Consultants

The consultants represent developers and investors in the development process, and they create project proposals that will become part of the North Harbour. They each get to develop a section by placing different structures on it, trying to achieve the highest income while also providing some of the resources that are important for the overall value of the neighbourhood. Their influence is limited to the internal arrangement of the section they are developing. The main mechanism in their gameplay is providing funds for the building of different structures, which in turn increase their income. They can also increase the value of their buildings by building certain structures that provide a benefit, thus increasing their income from residential or office buildings. In general, it can be said that the consultants focus on short-term goals. Any investment they decide to make is oriented towards increasing their income.

There are three different specializations within the consultant role: landlord, work environment and mixed use. The specializations present a preference for specific building types and functions for the consultants, but they do not prohibit building other types of structures.

Interactions

The roles introduced above influence the interactions that players are allowed to take, both among each other and in relation to the game itself. Most of these interactions are controlled by the game rules, but all players also can use one of the rewards in the game, the **discount tokens**, to take actions that are not necessarily allowed by the rules otherwise. Examples to these actions are also mentioned in the following sections, where the regular interactions are explained.

Interactions between the players and the game

The players interact with the game in rather different ways based on their roles. The planners manipulate the placement of project sections, while the consultants are building structures on the sections belonging to them. The planners are not able to build or demolish any structures, and the consultants have no direct influence on the placement of the sections, be that their own or any other section.

Apart from moving sections on the board and building structures, all players draw action cards in the game, which influence the actions they are able to take. These cards typically represent environmental factors, for example changes in the social or economic climate, resulting in advantages or disadvantages for the different players.

Additionally, the players can manipulate the rules to a certain extent, and buy certain actions in exchange for discount tokens. These include extra actions on top of those allowed by the rules, or the purchase of additional buildings by consultants or changing the number of project sections on the game board by the planners.

Interactions among players

While the rules specify the ways in which players can interact with the game, interactions among the players are not regulated. Players are free to experiment and try to negotiate with each other in order to get to more advantageous positions or to achieve their goals. Additionally, players can also use discount tokens as bargaining chips in the game.

For example, if a consultant would like their section to be placed in a position that would increase their income, they can offer to build certain structures that would help the planners achieve their goals, or they can offer to pay any number of discount tokens. The planners are then free to decide whether the deal seems worthwhile for them or not. Similarly, planners can also try to negotiate with the consultants if they need certain types of buildings to be or not to be built. Planners can also decide to collaborate with each other and take their actions jointly. This can be advantageous if a certain move would result in both planners earning points in some way. If the action is taken jointly, both players receive points associated with it.

Through these interactions, the players have to achieve their goals as best they can. In the end of the game, they receive scores, and the player with the highest number of points wins. The following section details the scoring system and the different aspects that are used for judging how well a player did in the game.

Scoring and winning the game

Players receive feedback in the form of scoring at different points in the game. After each player takes their turn, they receive rewards (increased income, discount tokens, or resource tokens) that help them determine their performance in the game. Additionally, after each stage, a short evaluation takes place.

The players can earn points in a large variety of ways. Consultants need to take into account their income in the end of the game, the total number of discount tokens earned, as well as the number of resources present on their sections; receive points for maintaining or creating a balance between different functions mentioned under their role description. They also receive points based on the number of discount tokens they have earned during the game, and the number of buildings that have an increased value on the board. The aim was to create a balance between different approaches to victory, and to reward different strategies instead of presenting one specific strategy as the clear way to victory.

So far, the chapter introduced the game and the development process it was based on. The final segment of this chapter introduces the site of the case study and the study population to complete the introduction of the case that is used for investigating the effects of games on the cognitive learning of planning students in relation to the social and economic goals in sustainable urban development.

4.3 The site of the case study - Aalborg University

Aalborg University is a Danish university, and it has multiple campuses in Denmark, two of which are in Aalborg and in Copenhagen. The teaching method at Aalborg University is mainly characterised by Problem-Based Learning, an experiential educational method that focuses on problem solving, and views the acquisition of new knowledge only as a means to that end (Wu et al. 2011). It's development is attributed to the McMaster University Medical School, where it was introduced in the 1960's (Neville 2009). It is typically characterised by group work and concentrates on solving not well-structured, real-life, cross-disciplinary problems as part of the student curriculum (Wu et al. 2011; Aalborg University 2010, 2014). Therefore, it offers the situated, reflective learning process that characterises experiential learning and provides a social learning experience (see Chapter 2.2.2), which has been noted to be important in planning education.

Besides its generally positive contribution to educating planners, the atmosphere provided by a problem-based educational approach also means that students get accustomed to working in such learning environments: group work and experiential learning are not new to them. Therefore, they can be expected to accept such novel educational concepts as game-based learning, where the focus is on these same attributes: experiential learning in a social environment.

4.3.1 The planning programmes – study population

The participants invited to the workshop were selected based on their field of study: they are all enrolled in the Urban Planning and Management MSc programme at Aalborg University or the Sustainable Cities MSc programme at Aalborg University Copenhagen. This means that all participants had a familiarity with the field of planning, but the two studies do not cover the same field entirely.

The programme in Urban Planning and Management focuses on the context of cities and urban development globally, and provides a view of the city as a complex social, physical and technical structure within both a global and a local context. An important concept is the global competition of cities, and providing development plans that are capable of guiding cities in this competition (Aalborg University, n.d. A). The topics of the first two semesters are *The complex city* and *Planning and power.* This underlines a second focal point of the programme: the complex power-relations in urban planning and development processes. On the other hand, the Sustainable Cities programme is more focused on the field of sustainable development, primarily in the urban context: on renewable energy production, green building and green mobility, and sustainable resource management (Aalborg University, n.d. B). Semester topics are *The role of organizations and business in sustainable cities* and *Sustainable cities in an institutional and societal perspective.* Putting aside the differences between them, both programmes put a strong emphasis on the interdisciplinary context and communication. The third semester in both programmes is typically spent as an internship or exchange semester and the programmes close with a master thesis.

The academic entry requirements of the two programmes are also identical: a bachelor degree in engineering, geography or natural sciences, and they are both open to international students. This means that typically, the background of students show a large variety both academically and culturally.

4.3.2 The participants – the sample

All students enrolled in the two programmes above were invited to the workshops. Attendance was voluntary, and altogether there were 15 participants in the two workshops: five from Sustainable Cities and 10 from Urban Planning and Management. Regarding the demographics of the participants, they were all between 20 and 30 years of age, and represent both genders: eight of them are male and seven female. They also represent a mix of different cultures: while they are mostly European, there was one participant from America and one from Hong Kong. Most of the participants were enrolled in the 2nd semester of their respective MSc programmes at the time of the workshop with only one exception, and twelve of them had other experiences with planning besides their current study at Aalborg University. Nine of them have been studying urban planning for more than 2 years at the time of the workshop. Overall, the participants can be considered familiar with the field of urban planning, however, their level of familiarity with the Danish planning system, which influenced the design of the game, is unclear. See more detailed information about the participants in Appendix O.

5 Analysis and interpretation

This chapter presents the analysis of the primary data in relation to participant learning, as well as the interpretation of the results in light of the state of the art on game-based learning.

The aim of this project was to answer the question:

How does a game affect the cognitive learning of planning students in relation to achieving different, often conflicting social and economic goals of stakeholders in a sustainable urban development process?

Learning was defined by the researcher as an increase in knowledge, and therefore this is what the analysis primarily focused on.

Findings

The research was based on the initial proposition that the game would show a positive effect on the cognitive learning of participants on the level of verbal knowledge and cognitive strategies in relation to the social and economic goals in a sustainable urban development process. If cognitive learning occurred during the gameplay session, this would influence player behaviour and player knowledge throughout and in the end of the session. The following patterns of outcomes were proposed by the researcher prior to the analysis:

- The verbal knowledge – the recall of information about certain topics – of players would increase from the pre-game to the post-game test.
- The players would behave in ways that show signs of learning about the various goals in the game during the session.
- The cognitive strategies – their awareness of their own level of cognitive knowledge – in relation to the game would increase during the session, measured by the similarity of self-assessed and tested knowledge of participants.

Overall, the results show the following:

- The verbal knowledge of players increased from the pre-game to the post-game test.
- The players behaved in ways that show signs of learning about the various goals in the game during the session, although in some cases they also showed that their knowledge was incorrect, and this knowledge was shared with the other participants regardless of its correctness.
- The cognitive strategies of players on average did not improve during the session. However, the majority of participants showed an improvement. Additionally, there was a positive correlation between prior familiarity with the rules and improvement in cognitive strategies.

Two out of the three proposed patterns were confirmed by the results. It was expected that the participants would show signs of learning based on the state of the art. However, the analysis of participant interactions shows some difference compared to the general position explored in the state of the art, as that suggested that the gameplay in itself would not initiate reflection or discussion of the rationales behind decisions between the players. The reasons for this discrepancy are unclear. Nevertheless, it is possible to state confidently that the game has a positive effect on the learning of participants, as they show signs of learning during gameplay, and improvements can be measured in

their verbal knowledge. However, the same cannot be said about high-level cognitive learning, as the influence of gameplay on the cognitive strategies of participants shows some ambivalence. While the majority of participants showed an improvement, those participants whose cognitive strategies declined showed a significant negative change. This suggests that the game in its current form and with the current approach of assistance cannot be used as a tool to improve the cognitive strategies of participants. This finding is also in accordance with the state of the art, as the literature is in agreement about the difficulties of facilitating high-level cognitive learning through games.

The findings present a possible direction of improvement in this area, however, as a correlation was discovered between participants familiarizing themselves with the game through the rulebook prior to the workshop and the level of improvement of their cognitive strategies. While not all participants showed improvement after reading the rulebook, the average value of participants that did so showed a measurable level of increase. It is important to point out that all participants received information about the game in the form of a presentation prior to gameplay, which evidently did not affect their cognitive strategies to the same degree as reading the rulebook. This suggests that ensuring that the participants are provided with some form of written material about the game, such as the rulebook in this case, is central if their cognitive strategies are to be improved.

Analytical approach

In order to answer the research question, the researcher analysed the data collected during the two workshops, one in Copenhagen and one in Aalborg, where planning students from Aalborg University played the board game created for this research project. The analysis was based on questionnaire data collected both before and after the participants played the game, as well as observational data collected during gameplay. This chapter presents the analysis.

In order to see whether the initial propositions were true, each of the three proposed observations were compared to the empirical evidence collected during the workshops.

First, the verbal knowledge of the participants before and after the gameplay session is compared. This provides information about whether this low-level cognitive learning occurred while playing the game. Second, behaviour of participants during the workshop is investigated with a specific focus on player interactions based on observations during the gameplay, in order to see whether exchanges of knowledge about the goals and roles in the game occurred, and whether the participants learned during gameplay. This analysis is based on two assumptions: the proposition of Duke and Geurts (2004) that the initiated learning process is indicated by questions from the participants; and that interaction between participants during gameplay, especially if they clarify their rationales or strategies behind actions are beneficial for cognitive learning outcomes (Harteveld 2011). Third, in order to find out whether the participants acquired high-level cognitive knowledge, their cognitive strategies in the beginning and end of the game are compared. This is done by comparing their self-assessed understanding of the game with their verbal knowledge. According to Kraiger et al. (1993), comparing self-assessed knowledge and empirical evidence is a good way of investigating whether or not participants are in possession of cognitive strategies in a certain field.

By investigating these three areas of learning, it is possible to draw conclusions about how the game developed as part of this project affected the cognitive learning of participants in the workshops.

The analysis is based on data collected through the questionnaires (see data in Appendix F) and the observational notes (see Appendix D).

In the following sections, the three segments of analysis are presented in sequence. All three segments are constructed in the same manner. First, the proposed outcome pattern is explained, together with a rationale about how this proposition was reached. This is followed the analysis of the data. Finally, the results of the analysis are interpreted in light of the proposed pattern and the theoretical background on learning.

5.1 Gaining verbal knowledge by playing the game

First, the change in verbal knowledge of the participants is investigated. According to the theoretical stance of the researcher, a positive change in the verbal knowledge of the participants is expected to be found, based on the statements of fellow researchers. However, such statements are not always backed by structured empirical evidence, nor do they focus on the conflicting economic and social goals in sustainable urban development. The change in knowledge is investigated by comparing the results of a pre-game and post-game questionnaire about the goals in the game. The analysis shows that the verbal knowledge of participants increased between the pre- and post-game measurement.

During the analysis, the questionnaire data from participant C07 proved not to be usable due to large discrepancies in the answers. Therefore, only 14 out of the 15 data sets are considered in the following analysis.

Average pre-game verbal knowledge of all participants

Prior to playing the game, the measured knowledge of participants about the game and their goals was 3.03 on average on the same scale. The highest value of pre-game knowledge was 5, while the lowest was 1.

The pre-game cognitive knowledge of participants could have originated from a number of different sources: familiarity with the development process prior to the workshop; the pre-game presentation; or familiarity with the game prior to the workshop. The first two were not controlled for. However, participant familiarity with the game prior to the workshop was controlled for, by asking participants whether they read the rules prior to the workshop, and in what depth.

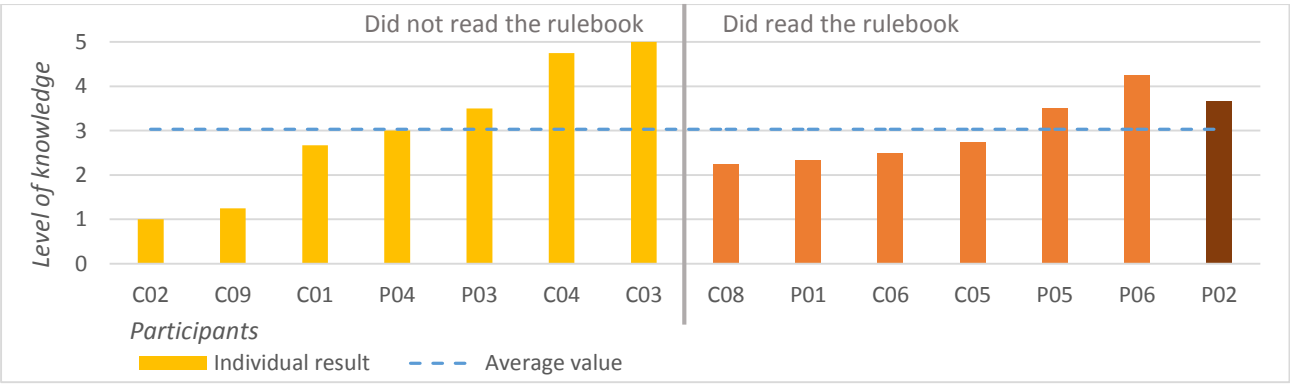

Figure 5.1 - The individual level of pre-game knowledge of participants compared to the average value; sorted by the level of familiarity with the rulebook prior to the workshop

The light colours in the chart indicate participants who did not read the rules prior to the workshop, while the dark colours indicate participants who have read the rules. P02, marked with an even darker shade was the only participant who regarded himself to have read the rulebook in-depth. Looking at the chart, no connection can be seen between the level of verbal knowledge of participants before the gameplay session and their familiarity with the rulebook.

Changes in the verbal knowledge of the participants

After the games ended, the final questionnaire was distributed to the participants, providing the necessary data for the assessment of their post-game knowledge. The test results showed a measured knowledge of 4.47 on average, with the highest value being 5 again, and the lowest being 3.

From the two sets of answers, it was possible to track the changes in the verbal knowledge of participants. The results show that the average end-game value of verbal knowledge was 1.47 higher than the baseline value.

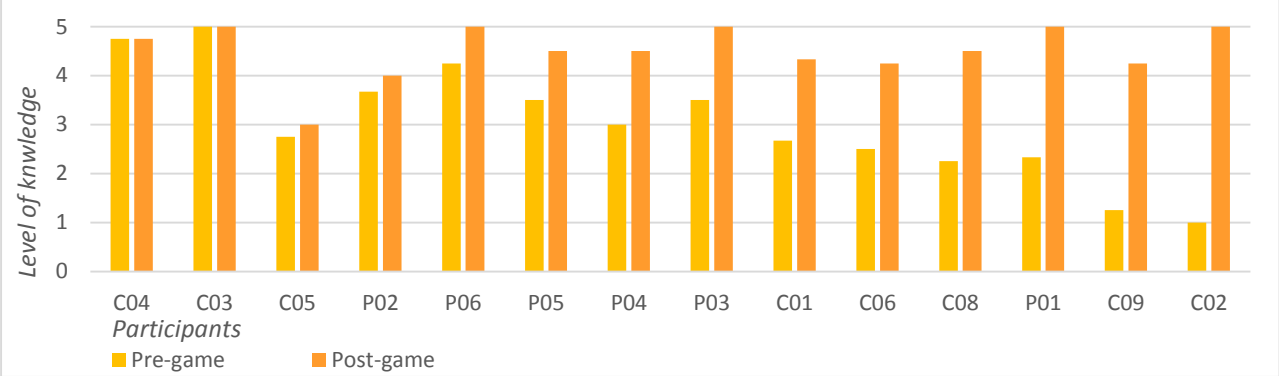

Figure 5.2 – Change in the verbal knowledge of participants, based on pre- and post-game data

Breaking the data down to the individual level shows that 12 out of the 14 participants had an increase in their verbal knowledge, and no participant showed a decrease, with two participants showing no change in their knowledge. The two participants whose verbal knowledge did not change during the session had the highest pre-game values out of the 14. Participants with a lower pre-game knowledge generally showed a higher level of increase. From the participants with a lower-than-average pre-game knowledge, only one showed a non-significant level of increase.

Interpretation

As expected, the results show that the level of verbal knowledge increased during the gameplay session. As the questions focused on the goals and strategic decisions in the game, this supports the initial proposition that the game is a useful learning tool in relation to goals and how to achieve them in a game based on a sustainable urban development.

The results of the analysis above show that the participants on average displayed an increase in their verbal knowledge between the pre- and post-game test, and that the majority of participants individually also showed an increase in knowledge. No participants showed a decrease. By obtaining data from the participants after the presentation but before they began playing the game, it was ensured that the data collection isolated the in-game learning from knowledge obtained from other sources prior to gameplay. This knowledge could have been gained either from the presentation, or from the rulebook,

which the participants received prior to the workshops. Reading the rulebook prior to the gameplay session did not affect the pre-game verbal knowledge of participants. The results reaffirm the proposed pattern, and prove that the game session resulted in learning on the level of verbal cognitive knowledge.

As the proposed pattern was based on the opinion of experts in the field of planning and games, as well as on prior research, no conflict exists between these and the findings. The results support the claims found in the literature with empirical evidence and, due to the topic of the game and the nature of the in-game goals, extends them to the topic of balancing social equity and economic growth in sustainable urban developments.

5.2 Assessment of learning based on participant behaviour

While the analysis of the questionnaire results provided quantitative information on the changes in participant knowledge between the beginning and end of the gameplay sessions, analysing the observational data about the behaviour of participants can support these findings with insights about how learning occurred in the course of the gameplay. The researcher expected to find that the participant interactions would reveal signs of learning. While the general position in the literature is that such signs are observable, these statements are generally vague and do not indicate structured data collection on the topic. Therefore, the aim of this research was to provide a more structured empirical support for the general perception by conducting a structured observation and analysing its results both qualitatively and quantitatively.

Analysing the behaviour of participants shows that knowledge in relation to the various roles and goals was exchanged during gameplay, and that the nature of the interaction between the participants changed during the course of the session, turning from curiosity towards expectance of transparency. The self-initiated exchanges of knowledge suggest that the game is indeed a good learning platform. The changes in behaviour implies that learning happened during the course of the game.

The questionnaires focused on participant learning primarily in relation to their own goals in the game. In order to answer the research question, it is important also to gain insights about whether participants learned about the goals of others as well as their own. Therefore, the analysis of the observational data focuses predominantly on learning in relation to goals and roles of other participants, in order to complement the questionnaire results better. It is also important to understand the way this learning happened – *how* the environment provided by the game affected learning. The observational data provides insights in this area, through analysing the interactions between the players.

The following sections present the analysis of participant behaviour. After introducing the analytical categories of participant interactions, each section presents and analyses participant behaviour considered under the specific category, supported by quotes from the participants, and followed by the qualitatively and quantitatively identified patterns. The segment ends with a summary and interpretation of the findings.

Interactions

In all of the sessions, participants interacted with each other, for example to discuss possible actions or to initiate negotiations with each other. Some of these interactions revealed that the participants understood not only their own goals and available actions, but also those of other participants. From the

conversations of participants during the gameplay, it can be seen that participants interacted with each other in these ways regardless of their roles.

When assessing the behaviour of participants during the gameplay, the researcher looked for comments or conversations that specifically related to player roles and goals, and the relation of certain actions or behaviour to these goals. Priority was also given to comments and conversations that implied that players understood, or sought to understand the roles and goals of other players. These types of comments were judged by the researcher to imply that the participants were in possession of cognitive knowledge about the roles and goals in the game, and that they were sharing it and reflecting on it, which most likely led to gaining further knowledge as well as the deepening of existing knowledge. The analysis was based on the audio recordings of the sessions, and consisted of a latent content analysis of the contents of the recordings.

The following table contains examples of comments that were regarded relevant for the analysis of participant behaviour, together with a short rationale for their inclusion:

Comment	Rationale
P02: "C02, what is your goal? You would like to build a lot of social apartments? No? Mixed use?"	P02 is clearly **curious** about C02's role and goal in the game.
P01: "But you can't do that." C02: "Because I would put it [a shopping centre] here [points to a plot]. Would this make sense for me?" P01: "No it wouldn't, because you won't earn anything." P02: "It would make sense if you put it there [points to another plot], because then you can build some housing here [points to a plot again]." C02:"Nah, but then it [the housing] is affected by the nightclub. (etc.)	P01, P02, and C02 are discussing the ways in which the structures are affecting each other's value, and try to **assist** each other to achieve their goals.
C02: "I'm considering buying a really big thing, so like a shopping mall. Well, we [him and the planners] need to be in dialogue here, so what do you want in my plot?" P01:"Well, we need more residential for sure." C02: "So would you pay me for this?" P01: "I wouldn't pay you, maybe P02 [social planner] wants to pay you."	C02 is trying to **negotiate** with P01 by offering to build whatever they need and trying to receive a payment for it.
C03: "Maybe you should, like, discuss the goals you have to us, so that we know...? Because we are just trying to reach our goals now, and then you said 'no, we don't need anything', but then..."	C03 is asking the planner to be more **transparent** about their goals so they can all cooperate better.
P: "So you are the mixed-use consultant." C:"Yeah, and now I have the same amount of offices and buildings." P: "Oh, so you don't care about the whole board, you just… on your project." C:"Yeah, I know!"	The planner is **reflecting** on the goal of the mixed-use consultant.

Table 5.1 - Examples of comments and conversations considered relevant in the behaviour analysis, with rationale for inclusion

As the table shows, within the overall topic of participant interactions, the rationale for including comments in the analysis showed some variation. The review of these rationales highlighted some specific topics, which formed the analytical categories of participant behaviour. They are as follows (in no specific order):

While the table offers examples for each of the categories, it is beneficial to summarize the meaning attached to each of the categories briefly before moving on to a more detailed discussion of each category and the analysis of the behaviour they represent:

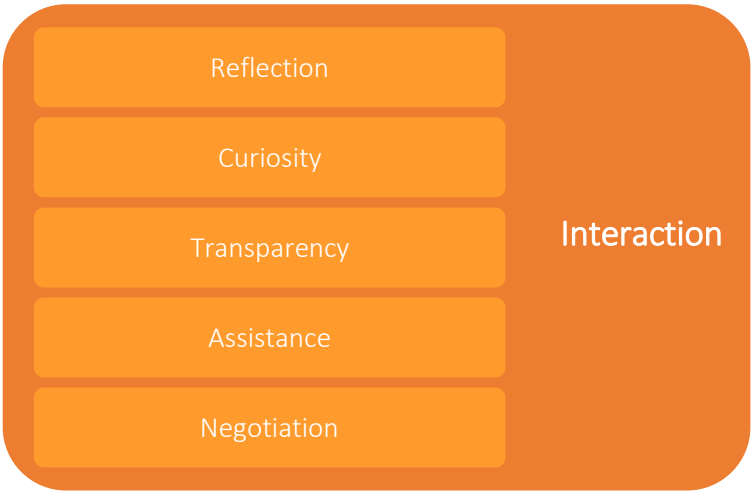

Figure 5.3 – The analytical categories of participant behaviour

- Reflection – when a player expresses understanding about another player's role, goals, or actions and the way they are connected;
- Curiosity – when a player explicitly asks another player about their role, goals, or actions;
- Transparency – when a player explicitly seeks to improve the transparency within the session, either by asking others to explain their actions or goals, or by volunteering information about their own actions or goals;
- Assistance – when a player offers assistance to another player in relation to their role, goals or actions;
- Negotiation – when players negotiate during the game in order to get closer to achieving their goals, especially in cases where understanding of the other players' role, goals or actions could be sensed from the negotiation process.

Reflection

From time to time, the players expressed their knowledge about the game – either about their own roles and goals, or about others'. These expressions or reflections on putative or actual understanding can be related to learning about the different goals and their relations in a number of ways. One, reflection on the players' own roles and goals provide an opportunity for other participants to expand their knowledge about these roles and goals. Two, from reflection on the roles and goals of others it is possible to track whether the participants understand the various roles and goals in the game, and whether this understanding changes during the session. And three, reflection during the gameplay might suggest that information was being processed by the participants on a higher cognitive level.

The following are examples of comments and conversations that involved reflection from one or more of the participants:

> *C02: "You're very welcome to move me over here in the metro area if you want to." C03: "There's no place for you over there!" C02: "Yes, you can just swap these, no? These ones…" C02: "Yes, but if you swap them, that's two moves!" R:"No, these two are the same size, so you can just swap them." C03:"Oh, yes, you can swap, move and rotate. Now I get it."*

This is a discussion of the possible actions of planners by two consultants. The researcher also joins the discussion, to correct a misunderstanding. Afterwards C03 lists the three possible ways in which the planners can move the sections on the board.

> *P: "So you are the mixed-use consultant." C: "Yeah, and now I have the same amount of offices and buildings." P: "Oh, so you don't care about the whole board, you just… on your project."*

In this conversation, a planner realizes that their previous assessment of the mixed-use consultant's goal was incorrect, and reflects on their newly gained knowledge.

> *C08: "It's a trap. Don't fall for it. If you don't want to do what he [P06] wants you to do, then just demolish it. That's what you wanted to do in the first place, and then your negotiation didn't work." C05: "Well I'm just not sure what to do. Can I consult any of you?" C08: "Well, your goal is to have a mix of residential. And his goal is to have office buildings."*

Here, C08 is reflecting on P06's behaviour, assessing it as a "trap": the planner was attempting to manipulate C05 so that they can achieve their own goal. Afterwards, C08 also reflects on the goals of both C08 – a Landlord – and P06 – an Economic planner.

> *"But CO2, you can upgrade your own park, it doesn't stop you from building a new one."*

In this case, while the planner is attempting to help the consultant, the knowledge expressed by the participant is actually incorrect.

As the above examples show, the participants expressed and reflected on knowledge about each other's roles and actions in various areas. The expressions came from participants regardless of their roles. In some cases, the comments reflected correct knowledge about the game, the goals and roles, and in other cases, they did not. Sharing inaccurate knowledge among the participants happened in all three sessions. In some cases, it was corrected by either another participant, the researcher or the assistant; but in other cases, it remained uncorrected, and resulted in the misunderstanding of certain aspects of the game (typically the income and resource system) by several participants.

From analysing the occurrence of these comments (see Figure5.4), no common significant pattern can be seen in the three sessions. The comments occur at various points during the length of the session, with no typical changes in frequency. There are no observable changes in the level of correctness of such comments either. In Sessions 2 and 3, the comments reflected incorrect knowledge more frequently than in Session 1.

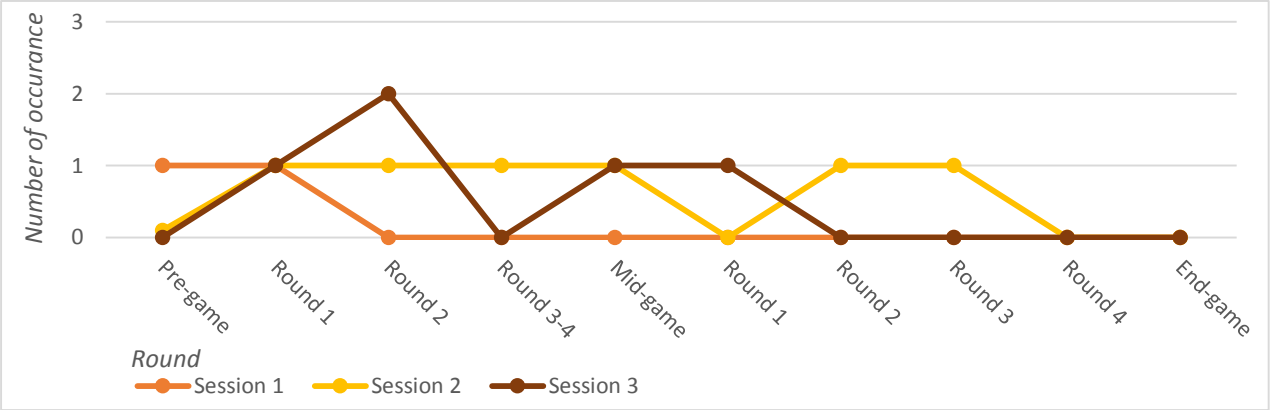

Figure 5.4 - Frequency of the occurrence of behaviour in the Reflection category in the gameplay sessions

Curiosity

During the sessions, participants asked questions – either from each other or from the researcher or assistant – about the way the game functions, about actions or mechanics, etc. For the purposes of this analysis, as it focuses on participant interactions, only questions that participants asked from each other were considered. A portion of these questions related to the roles and goals of other players, or to the way they were trying to achieve those goals, how certain actions related to the goals. This curiosity often led to discussions between participants about the goals and roles, which could have contributed to their learning.

> *P05:"So, how can you increase the value of the commercials?" P06: "You put the offices next the university, creative area or the metro"*

Here P05, the social planner, asks a relatively simple question from P06, the economic planner, about the mechanics that lead to them achieving their goals. It shows that P05 is interested in understanding the gameplay of the economic planner.

> *P06: "Why did you demolish the office building?!" C04: Because I don't need it, I'm focusing on residential."*

In this quote, P06, the planner, is asking for the rationale behind a consultant action. Consultants showed similar behaviour in relation to planner actions as well.

> *C04: "What is your goal?" C05: "My goal is to have a mixture of commercial and residential." C04: "But you should have 20% social housing, no? Or is that not the general rule." P06:"I think that's just the planners." C05: I mean, I'm looking only for my gains, cause I'm the consultant."*

This conversation reflects the curiosity of C04 about the goal of another consultant, and goes into some detail about it in a discussion.

> *C06:"I'm thinking what should I [build]? What does this area need? What do the planners think?" P: I think we need a park." C06: "Yeah, but I cannot build a park, because I don't have [the necessary resources]."*

The questions show curiosity from the side of C06, asking the planners what they need in the area. The conversation also belongs under Transparency, as the consultant is asking the planners to express their needs openly, so they can act accordingly.

> *C03: "By the way, why did you want big apartments over there [points at an area on the waterfront]?" P01: "Yeah, because it's on the waterfront." C03: "Yeah, but why?" P01: "Because we get more points." R: "But you get the same amount of points for any kind of apartment, by the way." P01, P02: "Ah, okay."*

In this conversation, C03 points out a misconception that the planners have about the value various residential structures have from their point of view, which therefore is corrected by the researcher.

As can be seen from the above quotes, the participants showed signs of curiosity regardless of the roles they played – and this curiosity related to players from both groups of roles as well. The focus of the curiosity also varied: there were questions about possible moves or actions, the rationale behind moves or actions, and the goals that players in different roles were trying to achieve.

An interesting observation is that the participants tended to reply to these questions, and thus reflect on their goals or on the game mechanics, as well as share knowledge among themselves about these topics. These discussions revealed much about each players' roles and goals in the game, as, according to the observations, the players – with the exception of C07 – did not try to deceive each other about their goals and the purpose of their actions. Through these discussions, in many cases the behaviour categorized under Curiosity led to behaviour that belong under other categories, such as Reflection, or in some cases even Assistance. In cases where the questions specifically requested that participants are open about their goals, actions, etc., the conversations or questions are also categorized under Transparency.

Questions or conversations that are identified as referring to curiosity between participants were found in all three sessions, following a different distribution until they ceased to occur in Round 3 of Stage 2 in each of the sessions.

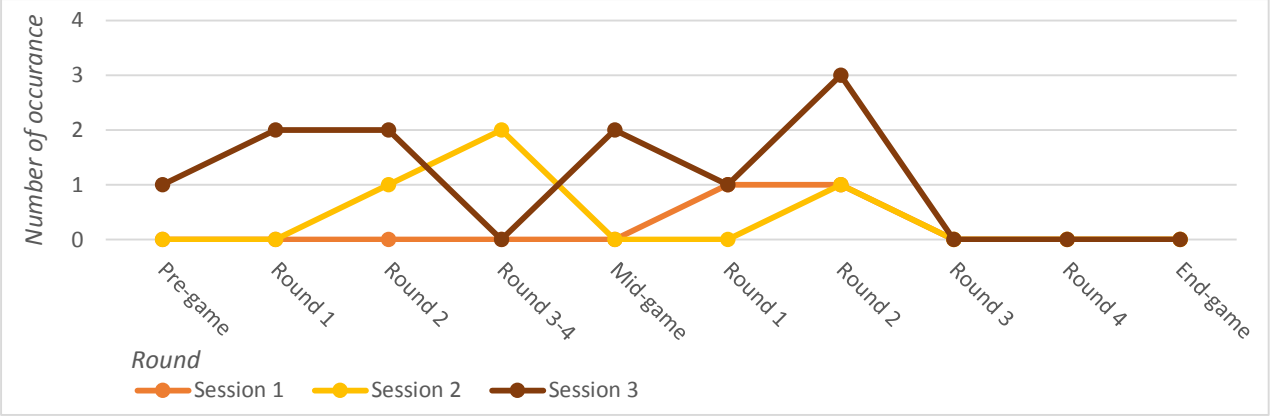

Figure 5.5 - Frequency of the occurrence of behaviour in the Curiosity category in the gameplay sessions

Transparency

This category refers to players aiming to be more open, more transparent about their goals or actions. As mentioned, it overlaps with the previous category to some extent, as many of the behaviour directed towards transparency also showed curiosity, but it explicitly refers to questions and statements where the participants called for explanation of others' actions or goals.

Some participants explicitly requested others to be more transparent during the gameplay. The following comments indicate the call for this transparency:

> *P02: "What was built?" [the players then proceed to discuss what everyone built or upgraded this turn]*

> *C02: "Maybe you should, like, discuss the goals you have to us, so that we know...? Because we are just trying to reach our goals now, and then you said 'no, we don't need anything', but then..."*

Other participants simply decided to be open about their actions, or goals and needs:

> *C07: "Ok, so for transparency I'll explain what I'm doing. I get 24 income from my project proposal. I upgrade one office, for 14 kroner with two random things, and get an office space for 8, so that's 22, and I have to use 4 discount tokens, I had 10 discount tokens at my disposal, so now I have 6."*

In all three sessions, there was an initiative for more transparency about the actions everyone took in a certain turn. The origin of this act of or call for transparency lied with the participants in each case, but its exact source varied: in two of the sessions, it was started by a planner, while in the third one it was started by a consultant. The comments of the participants suggest that the purpose of this transparency was to gain information about what the others were doing, and to try to understand how this affected their own progression in the game. While, as far as the comments indicate, the purpose of discussions was not directly to learn about the other players' goals, they nevertheless provided a platform for all participants to hear about what everyone was doing.

Regardless of these differences in the behavioural pattern, it can be seen in all three sessions that the planners are more active in asking the consultants about their actions in a turn, which is understandable if one considers the level of influence consultant actions have on the planner goals – nevertheless it shows that planners understood this influence. However, the same is not true about the more or less spontaneous expressions of transparency that can be seen in the second group of quotes above, which were more often initiated by the consultants.

In Sessions 1 and 2, the Transparency behaviour appeared early but significantly intensified in depth towards the end. In Session 1, for example, the first attempt for initiating transparency came from the planners' side in Round 3 in Stage 1. The planners were trying to follow the actions of the consultants, in order to track the changes in the proportion of the different functions on the board. Then as the game progressed, in Round 3 in Stage 2, consultant C03 told the planners that if they wanted the consultants to be able to collaborate, the planners should also communicate their goals and actions to the other players.

In Session 3, there were no real explicit attempts at increasing the transparency. Instead, there were continuous discussions about possible actions and their consequences between the players, which

meant that each participant was more or less aware of what the others were doing. The frequency of comments referring to transparency still increased somewhat towards the end of the session.

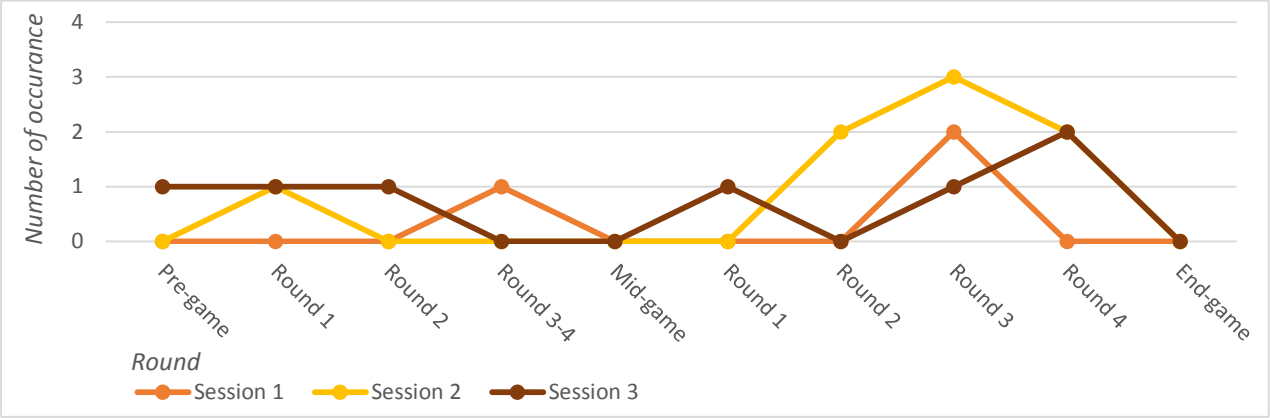

Figure 5.6 - Frequency of the occurrence of behaviour in the Transparency category in the gameplay sessions

The behaviour did not occur in the mid- or end-game segment, but in Session 3 it did occur in during the pre-game setup.

Assistance

Another typical interactive behaviour that could be observed during gameplay among the participants was assistance. Some participants gave advice to others and attempted to help them, either in relation to specific actions, or in some cases even about how to relate to other players, or how to achieve their goals. Some of these attempts at assisting others indicate a deep understanding of the game, of the goals and roles of not only the specific participant, but also those of other participants. Here are some examples.

> *P02 (social planner): "And then we move this down here, because then you have the offices near the metro."*

This comment shows that P02, the Social Planner, whose task is to increase the value of residential buildings, is also aware of how to achieve the goal of the other planner: to increase the value of office buildings.

Some Consultant players also attempted to help planners:

> *C03: "Yeah, but you can also move it and rotate it" [referring to a planned move from the planners during the negotiation].*

In some cases, these attempts at assistance turned into long and involved discussions, detailing various scenarios, with players sharing their insights about certain actions:

> *P01: "Do you want to put it [a shopping mall] there, because [the shopping mall]'s for residential. Do you want to move something maybe?" P02:"It makes sense because the shopping mall affects a lot." P01:"The residential, so..." P02: "Okay, so that's the residential that affects. So then we should move it up there, actually, to C03's section." P01: "But you can't do that." C02: "Because I would put it here [points to a plot]. Would this make sense for me?" P01: "No it wouldn't, because you won't earn anything." P02: "It would make sense if you put it there [points to another plot], because then*

you can build some housing here [points to a plot again]." C02:"Nah, but then [the housing] is affected by the nightclub."

While giving advice to others revealed that some participants had a detailed and in-depth knowledge about the game, it is also important to note that a significant portion of the advice given by players to each other was fundamentally incorrect in relation to the rules of the game:

P02: "So you can also that one [probably pointing at a park], and upgrade those. Because it makes more sense to upgrade than to build a new one"

Here, the planner is clearly not aware that consultants cannot upgrade their parks before they build more than one, because of the way the resource system functions. This shows that the behaviour is not related to the actual level of game-knowledge of participants.

As the above examples show, the assistance behaviour was shown by participants playing various roles, and in most cases, it showed their insight into the possible actions, roles and goals of others. However, on occasion participants assisted others regardless of the fact that their knowledge was incorrect.

According to the notes, the intensity to which players assisted each other in the sessions varied. Sessions 1 and 3 were much more active in this area than Session 2, where there were only a couple of comments that revealed Assistance behaviour. The behaviour did not occur in the pre-, mid- or end-game segments. Besides that, the occurrence of the behaviour does not show any specific pattern: Session 1 shows a relatively even distribution, in Session 2 it only occurred in the second part of the game, while in Session 3 it predominantly occurred in the first part of the game.

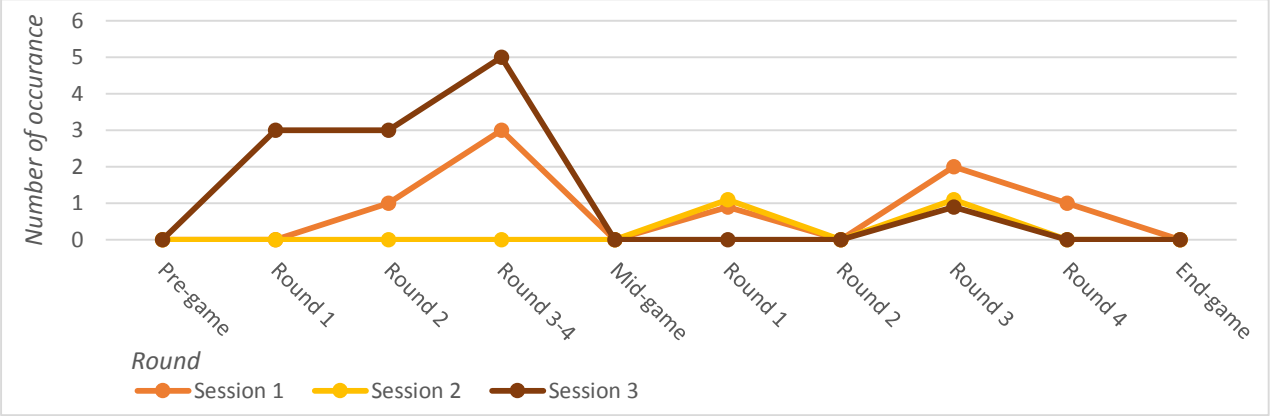

Figure 5.7 - Frequency of the occurrence of behaviour in the Assistance category in the gameplay sessions

Negotiations

An important interactive behaviour which, unlike the ones above, was encouraged by the game and the researcher was negotiation between the different players. These negotiations happened between participants playing various roles, and they show that the participants had some level of understanding not only of their own goals, but also those of others – this made it possible for them to offer deals that were beneficial for all parties involved, and therefore often successful.

Some of the initiatives for negotiations were clearly reactive of recently revealed information, such as:

P02: "We need some more social housing." C03: "Can I make a deal with you? I want to build 2 social houses. Can I get a deal? Can I get a token?"

C02: "Do you want like, some shopping mall, you said you have this wish for a shopping mall. Do you pay me something?"

In other cases, the circumstances of negotiations connected to curiosity about the needs of other players:

C02: "I'm considering buying a really big thing, so like a shopping mall. Well, we [him and the planners] need to be in dialogue here, so what do you want in my plot?" P01:"Well, we need more residential for sure." C02: "So would you pay me for this?" P01: "I wouldn't pay you, maybe P02 [social planner] wants to pay you." […] C02: "I can buy 3 average apartments, if you would like to." P02: "Deal. What do you want for it?"

Discussing the moves between the two planners in each session was also considered as negotiation in cases where the planners were trying to find actions together that would help them achieve their goals. Such discussions enabled planners to voice their concerns and make their goals clear to the other planner, as well as the other participants in case they were listening to these conversations. These negotiations therefore often entailed attempts to find a compromise, so that certain moves can be carried out in collaboration, making it beneficial for both planners:

P01: "How about this one, don't you want this one? It has 6 apartments, you can put them on the waterfront? And some offices." P02: "But that's social housing. We don't need more social housing." P01: "Yeah but it has 6 apartments, so it's balanced in…"

The negotiations could also take on a more aggressive form:

P02: "C02, what did you build?" C02: One social housing… P02: "Social housing? No! Not that!" C02: "I need to have balance! I have also a bonus to reach!" P02:"We don't need any more social housing!" C02: "You didn't tell me! And I have a bonus to reach." P02:"Demolish it next time." C02:"It will take you 10 tokens." (...)

And they could become really involved, leading to reflection on the various goals in the game and requiring calculations in order to maximize the benefits gained by all parties involved.

P02:"We have two tokens to buy three residentials." C03: "If you give me one, I can buy two, but I can't buy thee. But wait just a second, 'cause I need my balance. I have seven of one type and seven of the other type. I need the balance. So then I need…" (Facilitator clarifies that it can be two difference.) "Hm, so I can build, like, two big ones."

As the above examples show, participants in both consultant and planner roles engaged in negotiations. Reflecting the nature of the relationships between the different roles, negotiations occurred mostly either between planners and consultants, or between the two planners in the session.

According to the observational data, the distribution of negotiation behaviour varied in the different sessions. It is clear that no negotiations happened in the pre-, mid- and end-game segments of the game.

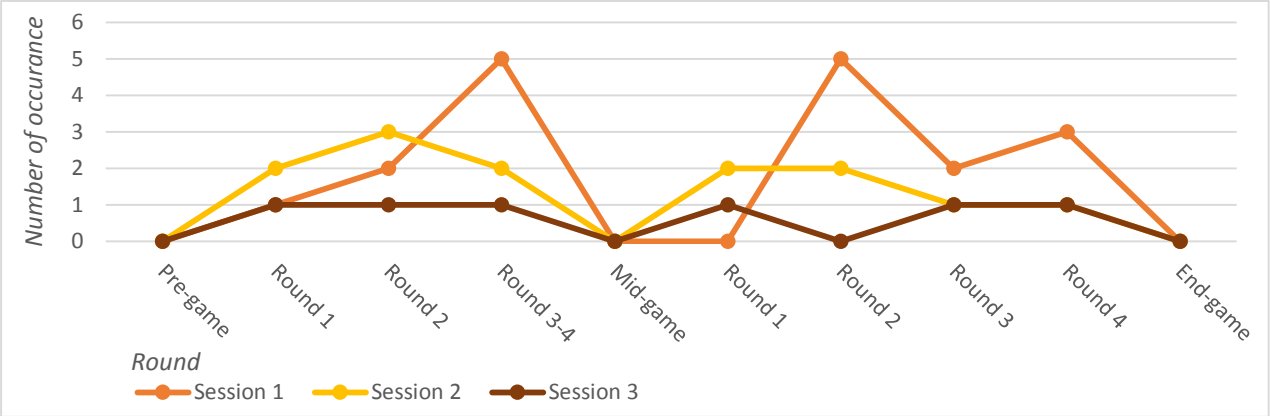

Figure 5.8 - Frequency of the occurrence of behaviour in the Negotiations category in the gameplay sessions

Summary

As the analysis of the different behavioural categories showed, the participants engaged in a variety of interactive behaviours, regardless of their roles. They asked others about their roles and goals, or helped each other during the game. They attempted to play in a transparent way, and negotiated with each other to optimize the outcomes of certain actions either for themselves or for others as well. Through these interactions, they displayed and exchanged knowledge about the different roles and goals in the game. In some cases, the knowledge shared by the participants was incorrect, and some of these incorrect pieces of knowledge were corrected, but others were not.

Many of these interactions were initiated by the participants themselves. While negotiations and some level of collaboration were encouraged by the rules and the researcher, the calls for transparency, curiosity about the actions and goals of others, and assistance were behaviours that were not explicitly necessary or encouraged.

Some patterns can be observed in the occurrence of the different categories of behaviour during the sessions. Assistance and negotiations did not occur in the pre- or mid-game period. Behaviours referring to transparency were also lacking in the mid-game, and no interactive behaviour could be observed in the end-game. Calls for transparency increased in both intensity and frequency of occurrence towards the end of the game, while signs of curiosity ceased in the middle of Stage 2.

Interpretation

The results of the analysis show that knowledge about the various roles, goals and their interrelations was shared by the participants during the gameplay. It also shows that the intensity of the interactions changed, namely that the interactions were generally less intense during the pre- mid- and end-game segments, which can be considered as not being part of the active gameplay. This means that they were more intense during active periods of the gameplay. The type of behaviours occurring in various segments of the sessions also shifted somewhat, from curiosity towards an expectation of transparency about participant actions and goals. These findings reaffirm the proposed pattern that participant behaviour would change during the course of the gameplay, reflecting the effects of the session on learning.

As the results show, no interactive behaviour was observed during the mid- and end-game segments, and very little interaction was observed in the pre-game segment. Based on these remarks it is possible

to argue that the gameplay influenced the learning process of participants, as it shows that active periods in the gameplay resulted in more active interaction, involving more active exchange of knowledge among the participants. These findings support the position discussed in the state of the art, as the participants exhibited behaviour that indicates learning.

Additionally, the results also point out that the game did result in spontaneous strategic discussions among participants, which was somewhat unexpected based on the theoretical background on game-based learning. The state of the art indicated that participants would need to be encouraged to discuss their rationales behind certain actions or their strategies, in order to ensure that they process the information on a higher cognitive level. Since the researcher did not do so, it is likely that either the participants were naturally inclined towards such behaviour, or the game possessed some quality that encouraged the participants to interact in this manner.

The shifts in behaviour are also telling. Behaviour related to curiosity was not observed beyond the first half of Stage 2. This could mean that by this point, participants were not trying to understand or figure out what others were doing; it is likely that their curiosity had already been satisfied. Another type of interactive behaviour became more common during this part of the game. Participants requested or displayed high levels of transparency about actions and their relations to particular goals in the game. This implies that the participants had some level of understanding about the interrelations in the game – the ways in which actions of others, and the overall state of the game board affected their own ability to achieve their goals.

The above observations suggest that a) since the active periods of gameplay coincided with the active periods of knowledge exchange, the gameplay had a definitive effect on the learning process and b) as the behaviour of participants shifted away from curiosity towards transparency, their knowledge about the game increased towards the end of the game. The latter reaffirms the results of the research about gains in verbal knowledge. The observation about the correlation between gameplay and knowledge exchange provides empirical evidence for the position of researchers in the field of planning games that games facilitate learning in complex, multi-goal and multi-stakeholder environments. It supports the statements cited in the state of the art that the gameplay initiates knowledge exchange in relation to the various goals and roles.

Overall, based on the observational data it appears that the learning process was initiated during the gameplay session. The players engaged in an experiential learning cycle, where the researcher provided guidance to ensure that the learning outcomes were correct. This result matches the predicted pattern that players would show signs of learning during the session.

5.3 Cognitive strategies

The final aspect of game-based learning investigated as part of the analysis is the improvement of the cognitive strategies of participants during the gameplay sessions. Cognitive strategies are acquired by gaining and organizing cognitive knowledge so that problems that are more complex can be solved by the participants in the targeted area, and it is also indicated by participants gaining awareness of their level of knowledge (cf. Chapter 2.2.1). Similar to the effect of the game on verbal knowledge, the researcher expected to find that the cognitive strategies of participants increased by the end of the game, i.e. that they became more aware of their understanding of the game and their goals. The proposed

pattern to some extent contradicted the position of researchers explored in the state of the art, as while not many references were found to the effect of games on cognitive strategies of participants, Harteveld (2011) for example does not consider games as an inherently useful tool for reflection, which is necessary for achieving high-level cognitive learning. The proposed pattern was not confirmed by the findings, as the results show an unclear picture about the changes in cognitive strategies between the beginning and end of the gameplay session. Therefore, it can be said that the findings are in agreement with the position of Harteveld on the usefulness of games in relation to high-level cognitive learning.

However, the analysis revealed a correlation between participants reading the rulebook prior to the gameplay sessions and changes in their cognitive strategies. This connection was not expected based on prior research, and it suggest a possible path of improvement if games are to be used for facilitating high-level cognitive learning – both in the field of urban planning and outside of it.

The analysis consists of comparing the self-assessed and tested knowledge of participants both pre- and post-game, and comparing the two sets of data, in order to see whether the level of similarity between self-assessed and tested knowledge changed, according to the following figure:

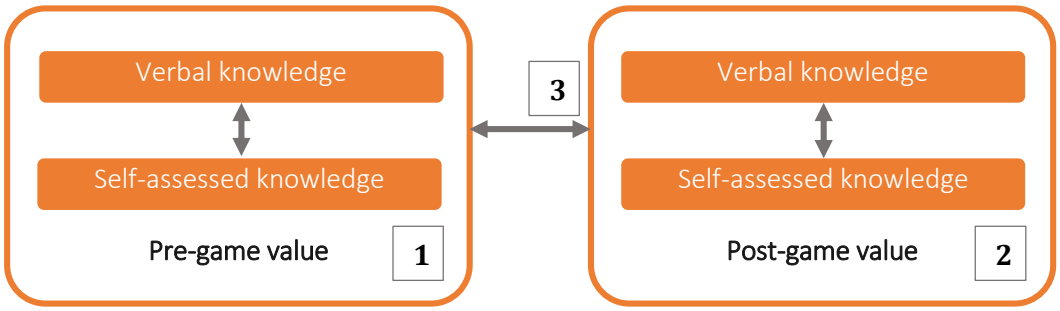

Figure 3.3 - Steps of the analysis for investigating changes in the cognitive strategies of participants

Pre-game knowledge of participants

Based on the questionnaire results, the pre-game knowledge of participants was distributed according to the following chart. The participants are listed based on the level of difference between their self-assessed and measured verbal knowledge.

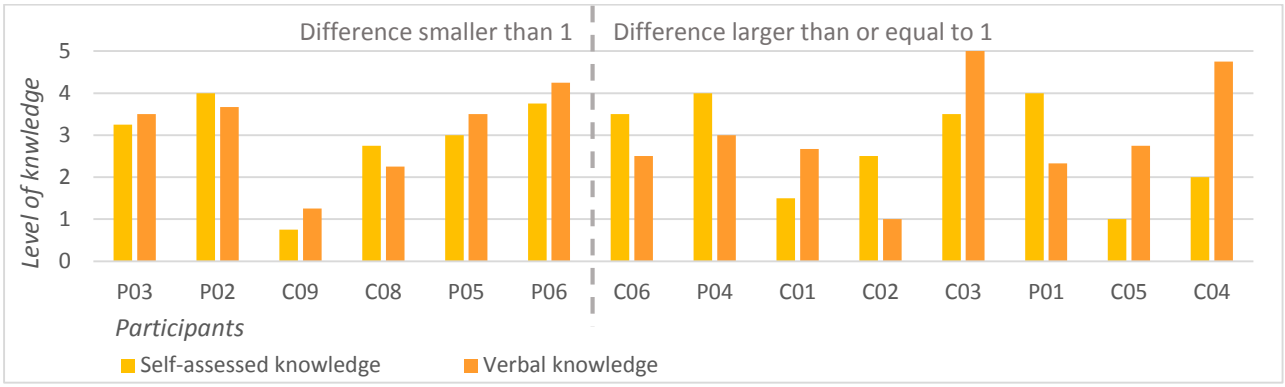

Figure 5.9 - Self-assessed and verbal knowledge of participants prior to playing the game

The chart shows both the measured and self-assessed pre-game knowledge of the participants. When comparing the two values for each participant, it is irrelevant which value is higher; only the level of

similarity is considered. The average difference between the two values 1.07. The participants assessed their knowledge prior to the gameplay session at 2.82 on average, with the individual values showing a large variety between 0.75 and 4. No participants assessed their knowledge higher than 4. As already discussed, the average value of the measured knowledge was 3.03, and it also shows a large variation, ranging from 1 to 5.

The levels of verbal and self-assessed knowledge of participants show no correlation. Considering a difference smaller than 1 to be reasonably similar, prior to the game only 6 participants showed a similar level of self-assessed and measured verbal knowledge. It can also be seen that out of the 6, 2 participants received average scores below a value of 2.5 on their measured knowledge, which can be considered very low – so while they were aware of the level of their knowledge of the game, said level of knowledge was very low.

As explained when analysing the changes in verbal knowledge, one aspect of the source of pre-game knowledge of participants was controlled for by asking them whether they read the rulebook prior to the workshop. Organizing the above chart based on whether or not participants read the rules prior to the workshop is interesting:

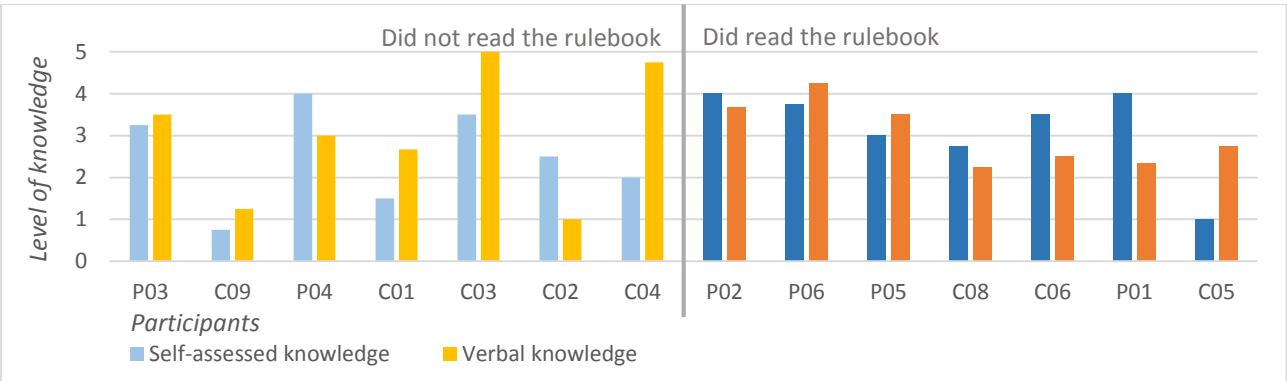

Figure 5.10 - Self-assessed and verbal knowledge of participants prior to the gameplay session, according to familiarity with the rulebook

From charting the data this way, it seems that while the verbal knowledge of participants did not show any correlation with this control, familiarity with the rulebook correlated with somewhat higher levels of similarity between the self-assessed and the measured knowledge of participants. The numerical average values reaffirm this assessment: they show that the difference between self-assessed and measured knowledge of participants who have not read the rules prior to the workshop was on average 1.24, while the other participants showed an average value of 0.89.

Post-game knowledge of participants

Looking at the post-game values for the same sets of data, a general increase in the values for both the self-assessed and measured participant knowledge can be observed.

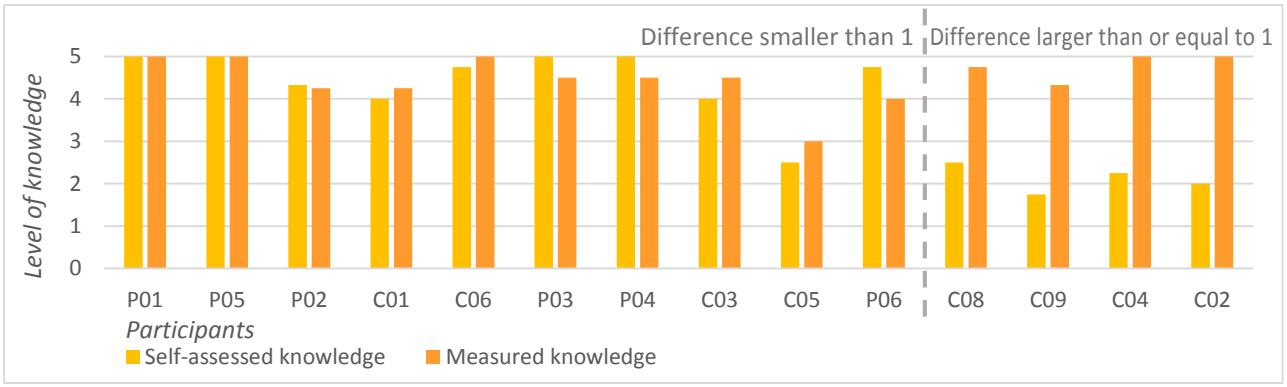

Figure 5.11 - Self-assessed and verbal knowledge of participants after the gameplay session

The post-game average of difference between the two values is 0.99. The participants assessed their own post-game knowledge at 3.77 on average. As can be seen from the chart, there was a large variety in how the participants assessed their level of knowledge in the end of the game. While most of them rated their knowledge quite high (higher than 4), there were 5 participants who felt that their knowledge was below 2.5 out of 5 even in the end of the session. The measured post-game knowledge of participants was higher than their self-assessed knowledge. On average, the participants' knowledge of the game was 4.5, and the individual values varied between 3 and 5.

As the chart above shows, 10 out of the 14 participants showed relatively similar levels of both their self-assessed and measured post-game knowledge (considering a difference smaller than 1 as relatively similar) – 4 more than prior to the gameplay session.

Considering the effect of familiarity with the rulebook on pre-game cognitive strategies, it is again interesting to look at the data organized according to the same filter:

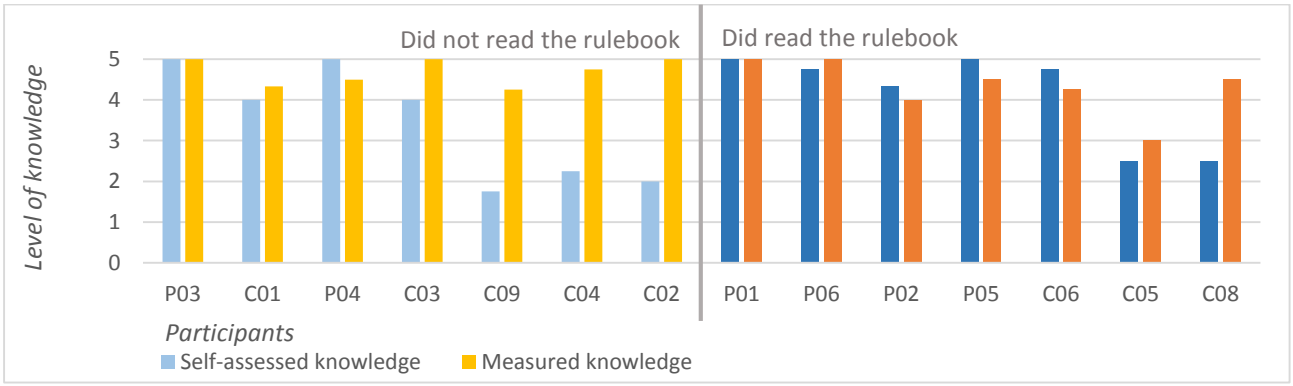

Figure 5.12 - Self-assessed and verbal knowledge of participants after the gameplay session, according to prior familiarity with the rulebook

The chart again suggests that the level of similarity between self-assessed and measured knowledge differs between participants who have read the rulebook prior to the workshop and those who have not. While 4 of the 7 participants who have not read the rulebook showed a difference between their self-assessed and measured knowledge equal to or larger than 1, only 1 of the 7 participants who did read the rulebook shows such a level of difference. Even more significant are the numbers: on average, the

difference between self-assessed and measured post-game knowledge among participants who have not read the rules is 1.4, while in the case of the other participants it is 0.58.

Comparing pre- and post-game data

The comparison of the charts in Figures 5.10 and 5.12 already suggests that the participants' cognitive strategies improved during the session. The average level of similarity showed no significant change from the pre- (1.06) to the post-game data (0.99). However, according to the results, 9 of the 14 participants show some level of improvement, and 6 of these participants show an improvement of 0.5 or higher. 2 participants show no change in their cognitive strategies. Finally, 3 participants show significant decline. The distribution of participants is illustrated in the following chart:

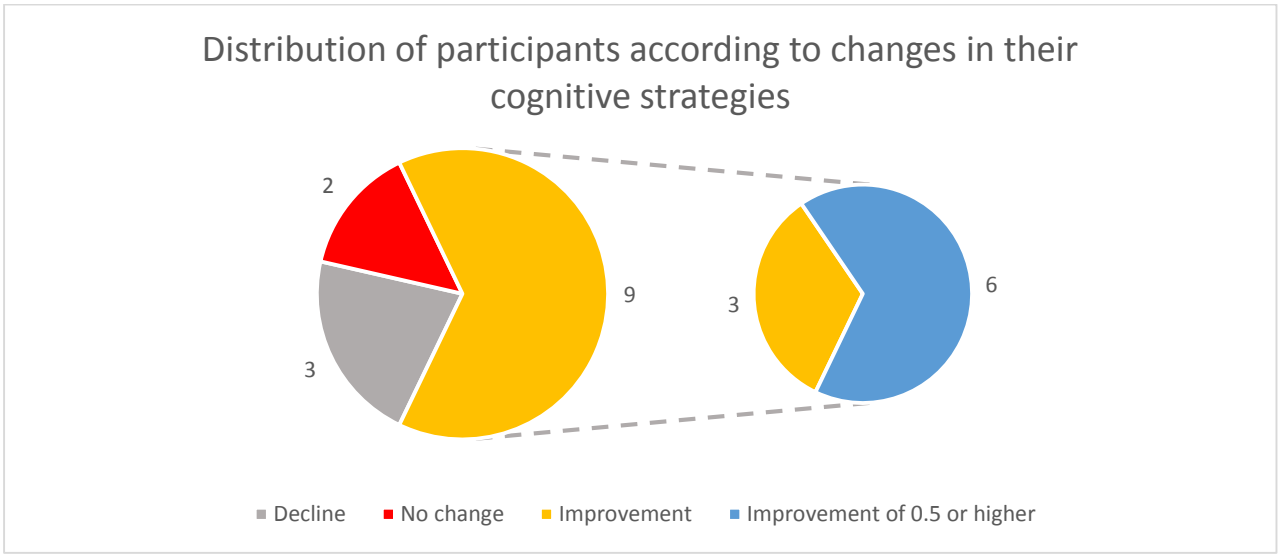

Figure 5.13 - Distribution of participants according to changes in their cognitive strategies

Taking prior familiarity with the game into consideration, the numbers show that the level of cognitive strategies of participants who have not read the rulebook prior to the gameplay session actually decreased somewhat, while the other participants showed improvement in their cognitive strategies.

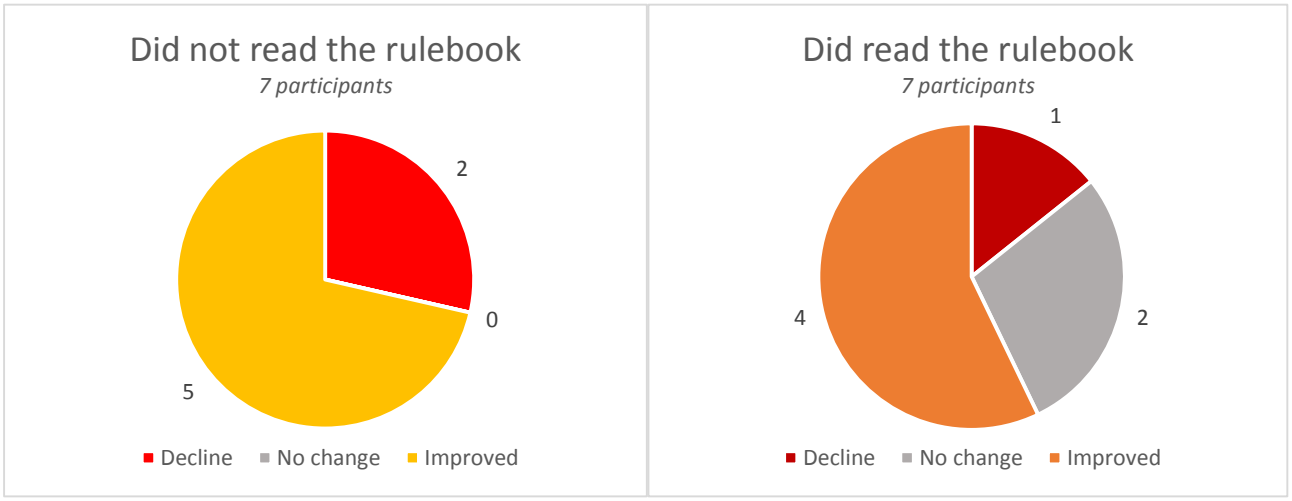

Figure 5.14 - Comparison of the changes in cognitive strategies between participants who did/did not read the rulebook prior to the workshop

Overall, among participants who did not read the rules prior to the workshop, the level or similarity between measured and self-assessed knowledge decreased by 0.16, while among those who did read the rules, it increased by 0.31. Out of the 5 participants whose post-game difference between the measured and self-assessed knowledge was not smaller than 1 (indicating a low level of cognitive strategy), only 1 read the rules before the workshop.

Of the three participants whose level of similarity between self-assessed and measured knowledge decreased between the beginning and the end of the gameplay session, 1 was familiar with the rules prior to the workshop. The level of decline was similar in all these cases, between 1.5 and 2.0. While the number of participants whose level of cognitive strategies increased during the gameplay was higher among those who did not read rules, the values show a different distribution. The average value of increase was 0.47 among the 5 participants who were not familiar with the rules, and 0.92 among those 4 who were familiar with the game rules. 2 participants showed no change in their level of difference between their self-assessed and measured knowledge before and after the gameplay session.

Interpretation

The results of the analysis suggest that while the average level of cognitive strategies did not improve significantly, the majority of participants obtained an improvement in their cognitive strategies during the gameplay session in relation to the investigated fields: what the goals were in the game and how it was possible to achieve them. However, the cognitive strategies of some participants declined during the session. Therefore, the proposed pattern cannot be considered clearly reaffirmed by the findings.

While the average level of cognitive strategies did not change significantly, 9 of the 14 participants displayed some level of improvement. The cognitive strategies were measured by comparing the self-assessed knowledge of participants with empirical evidence in the form of test results. A higher level of similarity between the two was considered indicative of higher-level cognitive strategies. Using this approach, the results show that after playing the game, most participants were more aware of what they did and did not know about the goals than before, but some actually became less aware of their level of knowledge. Therefore, the analysis showed that playing the game does not necessarily lead to an improvement of cognitive strategies in the case of all participants.

Comparing the findings with the state of the art on the use of games in planning, two things can be pointed out. First, during the course of this project, no research was uncovered that investigated the connection between high-level cognitive learning and the use of games. The reason for this is unclear, but it definitely showed a gap in the research, which this project attempted to bridge. However, the literature on serious games, most notably the work of Harteveld (2011) does point out that games are not inherently useful for higher-level cognitive learning, which is achieved by reflection on the experience in the game. This suggests a possible explanation: that the reason for the discrepancies in participant learning could be that some participants did not reflect on their experiences during the gameplay, while others did – thus processing the information on different cognitive levels.

However, controlling the level of cognitive strategies among participants for knowledge gained prior to playing the game in the form of familiarity with the rulebook provided unexpected results. On average, the cognitive strategies of participants who read the rulebook prior to the workshop improved, while

the cognitive strategies of those who did not read the rulebook decreased. Interestingly, the same control showed that the pre-game level of verbal knowledge did not differ between the two groups. So while participants who read the rules seemingly did not know more about the goals in the game, they were more aware of how much they did or did not know about those goals.

The literature reviewed did not contain any explicit references to this correlation between pre-game familiarity with the topic and high-level cognitive learning. Relating it to the process of experiential learning, one can argue that Kolb's theory considers the influence of prior knowledge in the learning process. During the experiential learning cycle, participants reflect on their experiences with the help of guidance from the instructor and their existing body of knowledge. This suggests that, while the literature on games in planning does not make the connection explicit, the above results could be expected in experiential learning situations.

6 Discussion

In the previous chapter, the analysis of the data collected during the gameplay sessions was presented, and the results were briefly interpreted in light of the theoretical background on learning. Looking at the theoretical framework of this research, the necessity of discussing the results and in relation to the background of planning and serious games is clear.

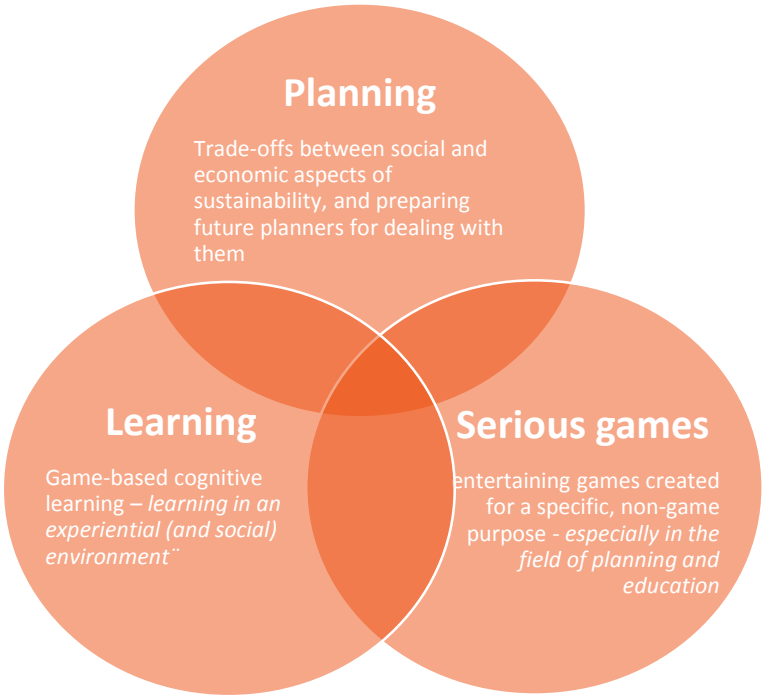

Figure 2.1 - The theoretical framework of the project

This chapter presents the discussion of some of the more interesting points that arose during the research in relation to these fields, in an attempt to generalize the findings of the case study to the broader field of planning education.

6.1 The planning perspective

Reviewing the theoretical position of the researcher that games would likely be useful tools for preparing planners to deal with the conflicts between the social and economic goals of stakeholders in sustainable urban development processes, on can see that the findings of the research so far only affirm this presumption partially. Nevertheless, there are strong suggestions that board games can be useful tools in preparing future planners for dealing with resolving conflicts between stakeholders in relation to the various social and economic goals in sustainable development processes. Both the empirical evidence collected in this case study and the opinion of researchers point in this direction.

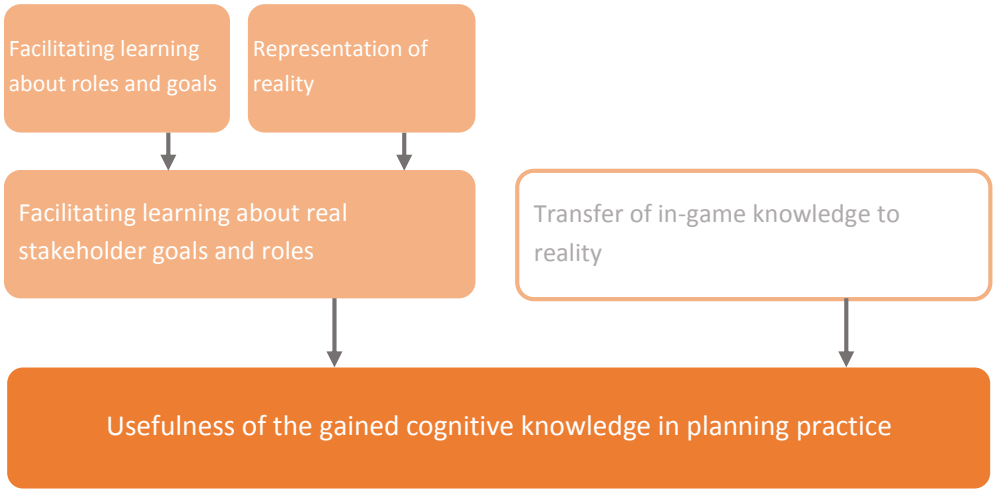

Figure 6.1 - Understanding the usefulness of the game in planning practice

When attempting to use a game as a learning tool about real goals and trade-offs between the different aspects of sustainable urban development, in order to ensure the players gain knowledge during the sessions that has a significance for them in practice about the actual planning process, the researcher finds two aspects that are especially important to be specifically considered. One is whether the players learn about the actual goals and their relationships in the development process. The other is whether the in-game knowledge transfers to reality, which, while not a subject of this research, is nevertheless an important aspect to consider when discussing the usefulness of games in urban planning education and practice.

Based on the results of the case study, the researcher finds it highly likely that games, if they are based on careful research and design, and if their contents are sufficiently validated, especially in terms of goals and stakeholder relations, are useful tools for facilitating cognitive learning in the realm of sustainable urban development. If it is a goal that players improve their cognitive strategies in relation to the various stakeholders, their goals and interrelations, the findings of the research suggest that it is useful to provide them with written material prior to gameplay (such as a carefully constructed rulebook, detailing the roles and goals).

Learning about the goals in sustainable urban development

It is not possible to draw direct conclusions from the results of the case study about whether it is possible for the participants to gain knowledge about the actual stakeholders and goals in a development process, as the game was not validated in relation to its representation of reality. Nevertheless, based on the results of the analysis it is reasonable to argue that if there is sufficient connection between the in-game goals, roles and relationships and those in the actual development process, a board game can be an excellent platform for planning students (or professionals) to learn about the complex stakeholder goals and their relationships in sustainable development. It can also be useful for students to process previously introduced material on a higher cognitive level.

Returning to Figure 6.1, the researcher finds two variables that are central in determining the usefulness of the game as a learning tool about the stakeholder roles and goals in a sustainable urban development process. One is whether the game facilitates cognitive learning in the area of these goals and roles, and

the other is the level to which the roles and goals in the game represent reality. Therefore, the research provides a partial answer to this question.

The first aspect has already been discussed in the previous chapter. The game was proven to be an effective platform for facilitating cognitive learning about the goals and roles in the game. The analysis of the data showed that players gained verbal knowledge about the goals during the gameplay, and that those who read the rulebook prior to the workshops increased their level of cognitive strategies about these goals. While there was also a short presentation on the topic of the development process and the game prior to the session, this did not help participants who neglected to read the rulebook to acquire the same increase in cognitive strategies. Therefore, it seems especially beneficial to provide participants with some form of written material focused on the stakeholders or roles and their goals prior to the workshop, in order to ensure and increase the beneficial effects the game provides for their cognitive strategies.

Turning to the second determinant, the level to which the game represents reality, the game was judged by the researcher as not sufficiently representative of the roles and goals of the stakeholders in the development process in the North Harbour. Decisions made during the design process resulted in especially planner roles that did not adequately represent the roles played by CPH City and Port Development or the planners working for the City of Copenhagen. Nor did the game include the entirety of the goals related to social and economic sustainability in the development process. Therefore, in this research it was not possible to investigate whether games enable players to learn about the actual roles and goals, and their interrelations and conflicts in the development process.

6.2 The effect of game design on cognitive learning outcomes

While the previous chapter showed that the analysis of the data collected about participant learning provides evidence that the game facilitates cognitive learning, it is interesting to view the results from another perspective, which was emphasized in the relevant literature: the way the design of the particular game used as a learning tool influences the learning of the participants. The most interesting observations about the relationship between the design of the game and the learning of participants come from two specific aspects of game design and learning: chunking information (or the lack thereof), and the question of reflection during gameplay.

During the workshops, the researcher found that players had significant difficulties processing the interrelations within the income and resource systems. This likely resulted of the number of aspects and complexity of interrelations that had to be considered, as well as the fact that players had to understand the whole system at once before beginning to play. Based on the literature on serious game design, it is likely that more careful pacing of the information load could have resulted in less confusion on the side of the players.

Another observation was that players engaged in reflections about the game during gameplay without being specifically prompted by the researcher. This is somewhat surprising in light of the serious game literature, where there are numerous claims that game do not prompt this type of behaviour. The reasons for this discrepancy is not clear, and it could be useful further to investigate its causes, for example by initiating a comparative study between digital and board games, or single- and multi-player games.

Chunking

The observational data, as well as the experience of the researcher during the workshops and other events when the game was played showed that the complexity of the game, especially the income and resource systems, presented a serious difficulty for players during the sessions. It is likely that this problem was caused by insufficient chunking of the information. This means that the loading of information was not divided into smaller segments, which resulted in players having to try to understand the overall complexity of the interrelations between the resources, income and goals in the game already before they started playing.

During the workshops and on other occasions when the game was played, the players complained about the complexity of keeping track of income and the various resources in the game. Observing participant behaviour in the different sessions made it clear for the researcher that near-constant assistance seemed to eliminate the difficulties participants had with understanding the income system and the way resources worked. However, in the workshop sessions 2 and 3, this level of assistance was not possible, and this resulted in a significant level of confusion on the side of participants. Additionally, as the researcher was not able to always participate in the discussions about the income and resources, faulted knowledge was shared and reaffirmed among the participants, and often was not corrected before the end of the game. Nevertheless, remarks were also made that this complexity is likely necessary for communicating the problem so that students actually have the possibility to learn.

Viewing this from the perspective of serious game design provided by Harteveld (2011) and supported by the observations of Duke and Geurts (2004), it seems likely that introducing the various resources and the income system at the beginning of the game caused this confusion. The players needed to understand the game as a whole right as the game started, which meant that chunking of the information into smaller rations and gradually learning the rules during gameplay was not possible. This disrupted the learning process. Furthermore, the observations underline the importance of guidance and feedback (Harteveld 2011), as they seemed to help players overcome the difficulties caused by the supposed faults in the game design.

These observations show that presenting such complex interrelations within a board game have to be carefully considered, and gradually introduced during the gameplay, in order to allow for chunking and thus to avoid overwhelming the participants with information. This would allow participants to process information at a more leisurely pace. This consideration can help designers to create board games that can facilitate cognitive learning in the complex field of sustainable urban development with the best possible results.

Reflection

Reflection by the participants on the game, its rules, the roles and their relations, was observable during the workshops, as has already been discussed in the previous chapter. Players repeatedly discussed the game and shared their insights about both in-game experiences – such as the way certain player actions related to achieving their specific goals – and the relationship between reality and the game. The reflection was not initiated by the researcher, nor was it specifically encouraged during the presentation or gameplay.

According to Harteveld (2011), games are not inherently good at facilitating reflection, which could negatively affect their effectiveness as tools for higher-level cognitive learning (cf. Chapter2.3.2). The reasons he lists for this are the likeliness of players to adopt a trial-and-error approach to understanding the game, as well as the amount of stimuli and the level of excitement that the game naturally leads to. Therefore, he stresses the importance of helping players disengage from the game and actively reflect on it, in order to ensure that the learning process is successful, by actively encouraging players to think about and discuss their strategies during gameplay. The observations of the researcher did not support this concept. While in many areas the players did choose a trial-and-error approach, they seemed to understand the effects of their actions, even though in some cases they only understood it in hindsight (but still before the end of the workshop). They were also willing and able to disengage from the gameplay and discuss their actions and goals, and reflect on the gameplay, without being prompted by the researcher or assistant to do so.

However, it is important to remember that Harteveld's (2011) observations are based on digital, predominantly single-player games. It is possible that multi-player games, or board games are better at facilitating interactive and reflective behaviour due to their social nature. The researcher was not able to find any comparative studies on the difference between board game and digital games or single and multi-player games in this area. Therefore, it is not possible to state definitively whether the discrepancy between the behaviour described in the literature and the empirical observations can be explained by the differences between digital games and board games, or single-player and multi-player experiences. Another possible explanation is that the site of the case study provides an environment where students are accustomed to experiential learning. It is possible that this results in them being able to guide their experiential learning processes better than otherwise expected: that they are more used to discussing their experiences with their peers, as well as to provide or ask for guidance either from fellow students or from their teachers (or, in the case of this study, the workshop facilitator).

7 Conclusions

The aim of this project was to investigate the way in which serious games can be useful in preparing planners for dealing with the various social and economic goals of stakeholders in sustainable urban planning processes. Therefore, the research set out to answer the following question:

How does a game affect the cognitive learning of planning students in relation to achieving different, often conflicting social and economic goals of stakeholders in a sustainable urban development process?

This chapter presents the conclusions of the research project and provides possible directions for future research.

Overall, the findings of the research strongly suggest that a carefully designed board game, with sufficient guidance and preparation of the students can be useful in preparing future planners for dealing with the conflicting interests and goals in sustainable development. Games are useful tools for increasing the verbal knowledge of students about these topics, and it seems that, if building on a prior familiarity with the material (e.g. with the rulebook), they can improve the cognitive strategies of students as well. Therefore, they can provide a strong basis of knowledge that planners are in need of when trying to resolve or negotiate the issues that arise in the planning processes of sustainable development.

In order to answer the research question, three fields were especially interesting to consider, and guided the direction of the review of past and current research: planning – especially the conflict and synergies between the social and economic aspects of sustainable urban development processes; learning – especially cognitive learning in an experiential, game-based environment; and serious games – especially for educational purposes and in the field of planning.

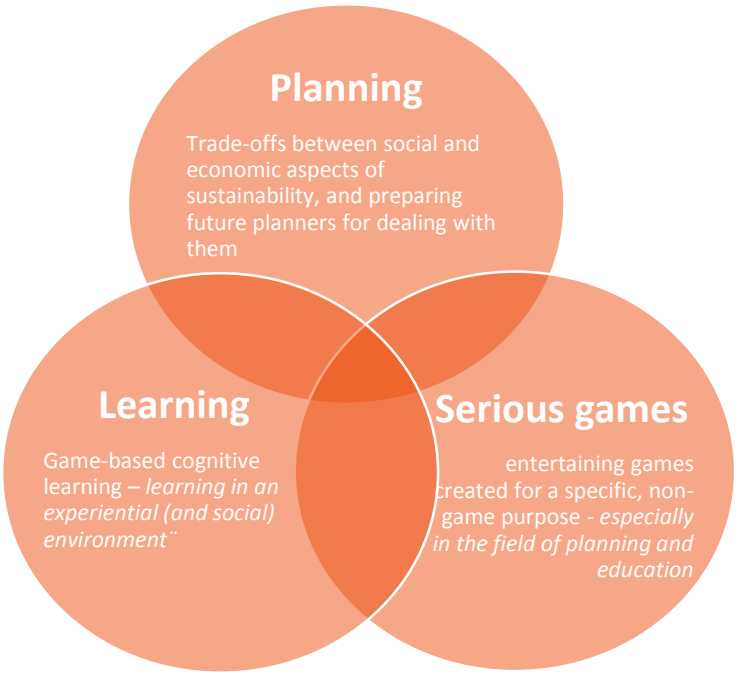

Figure 2.1 - The theoretical framework of the project

The review of the state of the art on planning and serious games showed that researchers agree about the usefulness of games as tools for learning about – and possibly also solving – complex, unstraightforward planning problems. However, it was also clear that many of the claims lack the support of well-structured, scientifically sound empirical research. Therefore, this research set out to conduct a case study with urban planning students, to investigate one of the less-straightforward areas: the effect of games on cognitive learning. Using a board game that focuses on achieving various social and economic sustainability goals in the development process in the North Harbour, Copenhagen with planning students at Aalborg University showed that this particular game is effective in communicating complex, conflicting in-game goals to participants.

7.1 The case study

Before the findings of the case study can be viewed in a broader perspective, it is useful to break down the process of the case study. The most important parts are: the learning tool that was used - a game created as part of this project; Aalborg University as the site of the case study; the workshops that facilitated the collection of the main body of data used in the analysis; and analysis, together with the findings.

The game is a competitive strategy game with role-playing and puzzle elements that was created about the development process in the North Harbour, with the specific purpose to facilitate cognitive learning in relation to the social and economic goals of stakeholders. In order to achieve this purpose, the game was based on the development process, and represents a segment of the area being planned and developed as a unit. The design process was guided by the recommendations of Harteveld (2011).

Image 7.1 - The game board representing part of the North Harbour area, during the final stages of gameplay

The roles the players enact represent planners and developers in the area, and their in-game goals are largely based on the stakeholder goals. The developers build structures in sections of the board allocated to them, while the planners are arranging these sections together with other, externally controlled projects. The main goal of the developers is to maximize their income, while the main goal of the planners is to achieve a balance between different functions, provide sufficient social housing and

increase the overall value of the area. The selection of the in-game goals was meant to ensure that the game serves its purpose as a learning tool about the stakeholder goals and about tactics that can help achieving them. Just like in actual planning processes, the actions of each player influence the overall outcome, and thus the ability of other players to achieve their respective goals. No clear winning strategy was provided, the players were free to interact with the game and each other, and find ways to win the game.

The game was played by urban planning students at Aalborg University, where the educational method is focused on problem-based learning, an experiential learning method that aims to ensure that students possess the skills and knowledge necessary for dealing with real life problems. The educational background of the students means that they are familiar with experiential learning methods, as well as with the concepts of social equity and economic growths, and their place in urban development processes. Prior to playing the game, the students received the rulebook, but they were not obligated to read it. The gameplay sessions were arranged as workshops at the Copenhagen and Aalborg Campus of the university, where the researcher briefly presented the development process and the game, facilitated the gameplay sessions, and provided a court debriefing where the game and its relation to the development process was discussed.

Image 7.2 - Planning students at Aalborg University playing the game

Following the recommendations of Mayer et al. (2014) and the definition of cognitive learning from Kraiger et al. (1993), the research evaluated the learning of participants during gameplay by comparing pre- and post-game measurements of their knowledge, as well as observing their behaviour during the gameplay sessions. This provided a combination of quantitative and qualitative data, which allowed for drawing conclusions about the way the game affected the cognitive learning of the participants on the specified topic.

Findings of the case study

During gameplay, the cognitive knowledge of participants increased on the verbal level in relation to the goals they were trying to achieve, and the mechanics in the game that allowed them to achieve these goals. The verbal knowledge of participants showed a general increase between the pre- and post-game

test. The effects of the game on the cognitive strategies, however, are less clear-cut. The cognitive strategies of participants showed no improvement on average, but the majority of participants showed improvement. On the other hand, the decline in cognitive strategies among the minority of participants was significant. Looking at the results from a slightly different angle, however, suggests a positive correlation between the familiarity of players with the rules prior to the gameplay session and the effects of the gameplay on this high level cognitive learning.

While prior familiarity with the rules apparently did not affect the pre-game verbal knowledge of participants, the majority of participants who read the rulebook before the workshop showed improvement in their cognitive strategies, and their average value also showed an improvement. On the other hand, even though the majority of participants who did not read the rulebook also showed an improvement in these strategies, the level of improvement was much lower, and the average level of cognitive strategies for this group of participants declined somewhat. This discovery is all the more interesting, as all participants were introduced to the development process and the game in the form of a brief presentation in the beginning of the workshops.

7.2 The broader perspective

The case study showed that the game was useful for facilitating the increase of verbal knowledge of participants by providing an environment where students attempted to achieve the goals in the game and interacted about their goals and strategies. Provided that the students read the rules about the game, it also seems that the game facilitated increase in the cognitive strategies of students. However, in order to answer the research question, it was also necessary to interpret the results in the broader field of planning and planning education, and to understand how the design of this specific game affected cognitive learning.

Planning

In order to draw conclusions on the usefulness of games in relation to real-life goals in sustainable urban development processes, the researcher broke down the problem into the following segments:

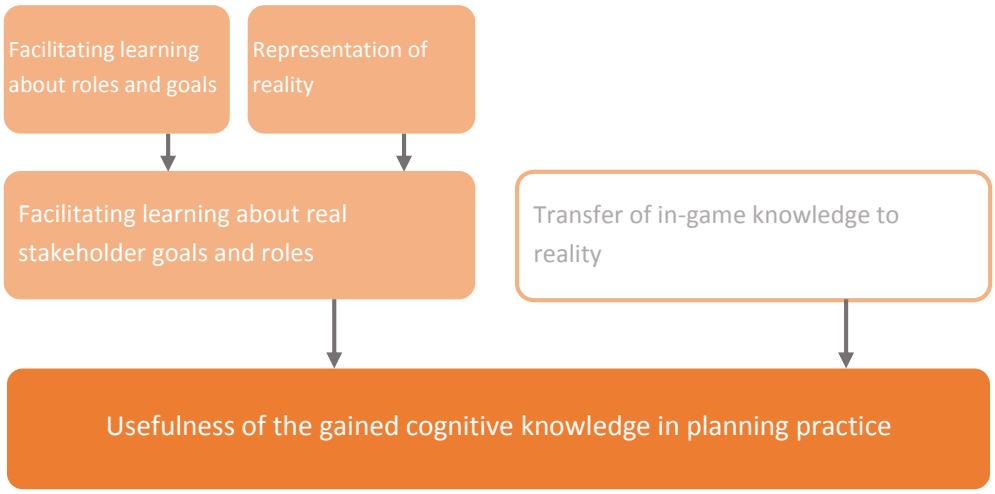

Figure 6.1 - Understanding the usefulness of the game in planning practice

Based on this figure, it is possible to relate the conclusions of the case study to the broader focus of the research.

As the above discussion shows, the game proved useful in facilitating verbal learning about the roles and goals, and it seems that with careful introduction of the rules, it can even effect the cognitive strategies of students about such situations, allowing them to become more aware of their level of knowledge about the subject matter. However, based on the review of research in the field, other points can be made that influence the usefulness of the game in the context of planning education. In order to use a game as a learning tool about the actual roles and goals in the development process, and the context-dependent or universal conflicts and synergies between social equity and economic growth in sustainable urban development processes, it is vital to make sure that the game represents reality as closely as possible. Most importantly, the goals and their relations, as well as the approaches that lead to achieving certain goals need to be implemented very carefully, and the model of the game has to be validated by researchers and professionals working in the field. Secondly, it is important to ensure that the in-game learning translates to an increase in the knowledge of students that is also useful in practice. The review of the literature suggests that careful consideration of the desired learning outcomes and the implementation of mechanics that support those outcomes should lead to games that enable such transfer from the game to reality. Based on this view, as the game showed effective as a learning tool in most areas and the majority of the considered mechanics were implemented successfully, it is likely that playing the game provides the students with knowledge that transfers to reality. However, the exact requirements seem somewhat unclear to the researcher on this topic, and the long-term effects of the game were not investigated.

Therefore, it is reasonable to state that games, if the model is carefully designed and validated, are useful tools for facilitating learning in the area of understanding the dynamics between social and economic goals in sustainable urban development processes. Based on the recommendations of the literature, it is also likely that such knowledge gained through game-based learning would transfer to reality. However, the researcher feels that requirements for ensuring transfer between in-game cognitive knowledge and reality should be better understood.

Serious game design

In order to understand the way game-based learning can be utilized in the field of educating planners about sustainable urban development, it is necessary to account for the effects of the game design considerations on the cognitive learning of participants during the case study. The most interesting points relate to player reflection on actions and their consequences during gameplay and the difficulties encountered when attempting to create a board game to teach about goals with complex interrelations, such as the synergies and conflicts in sustainable urban development processes.

Relating high-level cognitive learning to reflective thinking during gameplay, Harteveld (2011) states that games are not useful by nature in this area, but require conscious intervention by the facilitator in order to ensure that players reflect on the gameplay and their actions, and thus enable changes in their deeper understanding. However, the research suggests that during the gameplay session in this multiplayer board game, the participants naturally engaged in reflective thinking and behaviour without any specific prompts from the facilitator. While investigating and understanding the origins of this discrepancy between the literature and the findings was not possible in this research project, this might

mean that the social nature of multiplayer board games provides a platform that is more beneficial for this type of learning than digital games, which were the focus of Harteveld's (2011) research.

Turning specifically to the conflicts and trade-offs between the social and economic sustainability goals, the conversations and comments of the players show that knowledge was shared in relation to the complexity of the goals during the game, and participants discovered some of the relationships and conflicts between them. The game provided a platform for a social and experiential learning process, where participants reflected on the gameplay and shared their insights and questions with each other. However, in some cases, faulted knowledge or assumptions were shared in this process, which led to further confusion among the participants. This observation underlines the importance of guidance in game-based learning strongly recommended by the literature on the subject. In the session where sufficient guidance was available, much fewer misconceptions were observed among the participants compared to the sessions where guidance was sparse.

It is also important to point out the limitations of the board game format in relation to communicating the complexity of sustainability and planning problems. The most common difficulties for participants during the gameplay arose from trying to understand and follow the calculations required. It was suggested by serious game experts that the calculations should be done "in the background", however it was concluded that the simplification of this aspect could lead to a decrease in the usefulness of the game as a learning tool. Again, further research needs to be dedicated to finding the ideal balance between complexity and simplicity, and to determine the circumstances that can optimize board games as useful learning tools in relation to the complex interrelations and trade-offs between stakeholder goals related to various aspects of sustainability in planning processes.

7.3 Recommendations for further research

Based on the experience and insights gained during the course of the research project, two directions for further research appear interesting to the researcher: the effect of providing the players with written material relating to the learning goals prior to gameplay, and the differences between single- and multiplayer or board and digital games in facilitating reflective behaviour. Better understanding of these topics could provide guidelines for the creation of games that can be effective in facilitating cognitive learning on a higher level and could ensure that the knowledge that students gain by playing the game is helpful in their work as planning professionals.

The researcher suggests the following questions to be investigated:

How does prior introduction of the rules to the participants affect the cognitive strategies acquired during gameplay about the conflicting stakeholder goals in relation to social and economic aspects of sustainability? How and why does reading the rules at an earlier time and being presented with them right before gameplay differ in this context?

The most surprising finding of this research was that students who read the rulebook prior to the workshop exhibited much higher increases in their cognitive strategies than those who have not read the rules. While the students received a brief introduction to the game prior to the beginning of the gameplay session, this was apparently not enough to eliminate the differences between the two groups. The cognitive strategies of students showed significant differences in the two groups despite the fact

that their verbal knowledge was at a similar level. These observations suggest that familiarizing the students with the game in a written form prior to the workshop might be especially beneficial if the aim is for them to acquire high-level cognitive knowledge, but this topic was not covered in the state of the art. Therefore, further research into the exact nature of this influence, as well as its causes could be beneficial.

What are the differences between digital and board games, and single- and multiplayer games in facilitating cognitive learning in relation to the social and economic goals in sustainable urban development processes?

The insights gained during this research project suggest that the answer lies in a combination of two areas. First, the ability of the game to include and effectively convey a model that is sufficiently complex to communicate the synergies and conflicts between the various goals, yet simple enough to understand and allows the game to be fun as well as educating. Second, the ability of games to facilitate interactive, reflective behaviour of participants without being specifically prompted to behave in such ways.

The review of the literature on the topic showed that digital games can include models that are more complex, simply because they are capable of running the necessary calculations in the background. However, it seems that multi-player board games are better than single-player digital games at providing an interactive, reflective environment, as they enable direct interaction between players, thus enabling social as well as experiential learning. Therefore, it would be useful to understand the exact nature of the trade-offs between digital and board games, as well as the benefits of face to face interaction in multi-player environments, and a dedicated, comparative study could provide important insights in this area.

8 Reflections

This final chapter of the report summarizes the most important experiences and reflections in relation to the research project, in relation to the following topics: data collection, validity, the changes in the research design, the game design, and the cross-faculty collaboration during the creation of the game.

Data collection

Questions should have been asked in the questionnaires about the goals of opposing players as well. This would have made it possible to gain a clearer, more explicit image of the cognitive learning in relation to complex goals and the conflicts between those goals. As it stands, the data was more focused on learning about each individual goal. The analysis of participant behaviour provided some insights into the learning about the other goals and the conflicts, but it is not possible to draw clear conclusions about whether or not this learning took place before the game-play session, and how the knowledge of participants changed on the different cognitive levels in this area. It is also possible that asking for examples in the questionnaire have led to a misunderstanding where participants did not provide a complete list of actions or goals, even though their knowledge would have allowed it. Also, asking the participants to explain what they did instead of what they knew to be the correct answer could have also affected the results.

Not all data gathered through the questionnaires was used in the analysis, as the design of the research changed and the subquestions about the effect of various background variables on the learning outcomes were dropped. This excess data collection could have been avoided by more careful design of the research, but it is also possible that it will prove useful in the afterlife of the research. It can for example provide more in-depth insights into the circumstances of the case study: did students enjoy the gaming intervention, did they find it useful, etc. Or it might provide basis for further, more in-depth analysis of these aspects as part of a later research building on this one.

The analysis of participant behaviour based on the audio recording carries a number of problems in terms of its value for the research. First, it only conveys audible information, therefore if participants do not raise concerns, questions, or reflect verbally during the game-play, it is not possible to gain insights about their understanding of the game. Second, in some cases it was unclear which participant speaks, which could lead to further confusion in the analysis and this could affect the conclusions of the research. Therefore, in such cases the origin of the remark was marked as uncertain, either by assigning it in general to the session, or by assigning it to particular roles (i.e. to “planners” or “consultants”). This made the tracking of the behaviour of each individual somewhat inconsistent. In future research it would be beneficial to use video recording of the sessions, however this demands significant resources and a more precise setup of the game-play area, ensuring that each participant is visible on the recording.

Reflections on validity and reliability

Generalizability of research based on a single case is limited in the sense that the findings will be strongly influenced by the particular setting in which the research is carried out. One specific example from this project is the question of participant biased towards game-based learning. As the workshops were not mandatory for all invitees to attend, it is likely that the sample is biased: the students that elected to attend the workshops are likely curious about non-traditional learning tools or games in particular. A

larger study population, multiple cases, and random sampling techniques could improve the generalizability of the results.

Establishing a case study database would have positively impacted the reliability of the research, as it would have improved the recoverability of the research process.

Changes in the design of the research

The scheduling of the project changed a number of times in the first month. First, the originally selected case was discarded, and a new one had to be found, which already limited the time allocated to data collection. Second, the involvement of the Medialogy group meant that the schedules of the two projects had to be balanced. This meant that data collection about the case had to happen before the review of the state of the art was completed, and therefore the process involved a lot of confusion, as the researcher did not have a clear concept of the game design methodology. These problems were solved to some degree during later changes, but a more carefully implemented schedule could have resulted in a more insightful analysis of the development process, and would have improved the design of the game.

The original research design included a number of features that were eventually not feasible to implement, but could have strengthened the results of the research. These changes include not having a control group who receive either a lecture, or another, experiential type of introduction to the stakeholder goals. This would have allowed drawing conclusions on the relative effectiveness of game-based learning compared to these other approaches.

Another change made to the original design was the use of audio data instead of video recording of the workshops. The consequences of this decision have already been discussed.

Finally, the original design included subquestions about the effect of various background variables on the learning outcomes, but due to lack of time, these were discarded during the analysis. The preliminary analysis touched these topics, but it did not lead to conclusive results, therefore it was decided that a more in-depth analysis in relation to the main research question would be more beneficial.

The changes made in the questionnaires between the workshops means that the data collected in the first and second workshop is somewhat different. These changes were necessary, but they do affect the analysis to some degree. Nevertheless, allowing for the changes likely resulted in better information about the changes in participant knowledge, as the questions became more focused and mistakes were corrected.

Reflection on the game design and the workshops

While creating the game, countless decisions were made on how to relate it to the development process. Resulting from these decisions, in some cases the development process is reflected in the game, while in others the two are drastically different. In this section, the most significant decisions are highlighted.

Certain elements of the game were inspired by the Sustainability Tool (The Urban Design Centre, n.d.). The selected aspects of social sustainability are represented in the game through resources: green areas, urban space, urban life. In other areas, the practical knowledge and judgement of the creators were influential, such as the symbiosis or conflict between specific functions. Balance issues also influenced the design. One result of this is the cost and reward of structures for the consultants. Another area where

this was especially influential is the role balance between the social and economic planner, which resulted in a number of significant changes compared to the reality of the development process and the planning system.

In some cases, it was important to create a clear distinction between the goals of the social and economic planner. While these distinctions do not always reflect reality, they improve clarity and help the players understand their goals in the game better. They also help making sure that the players have more or less the same level or responsibility and a similar amount of goals in the game. For example, planners have to make sure to increase the value of certain buildings by placing them close to parks, creative areas, or certain parts of the map representing the waterfront or a metro station. This could be understood as a clearly economic task, but a distinction was made between increasing the value of residential buildings and commercial buildings, assigned to the social and the economic planner respectively. The reasoning behind this decision was that increasing the quality of life for the residents could be seen as a social interest. Some of the goals of the planners in the game are common for both planners. This means that in case of the ratio of social housing, the economic planner works towards a predominantly social goal. However, here it is important to remember that CPH City and Port Development is owned by the Danish state and the City of Copenhagen. This might mean that the economic planner has to comply with certain goals that the social planner stands for, even when this leads to a lesser development value.

An important insight in relation to game-based learning is that it is imperative that the purpose of the game, the gameplay and the investigated learning is in harmony. Since extensive testing of the game was not possible prior to the sessions, and significant changes had to be made between the goals of the stakeholders and the goals of the players in the game, the decision was made to investigate in-game knowledge rather than knowledge about the development process and the goals of the stakeholders.

There are a number of factors that could have influenced the learning and knowledge of participants that are to some extent independent from the game itself. Some of these factors are: the researcher and assistant, as they provided guidance and information, and often volunteered information and advice on gameplay to the participants; other participants, their attitudes or knowledge about the game – in social learning settings this aspect cannot be disregarded. However, the level to which guidance and assistance – be it from the facilitator or from peers – can be separated from the game experience is questionable, especially in a multi-player game.

Cross-faculty teamwork and learning

A large portion of this project was based on a collaboration between the researcher, with a background in urban planning and architecture, and a student group with a background in media technology and game design. The two groups represented vastly different types of knowledge, which all contributed to the final design of the game.

The media technology group had to gain a basic cognitive understanding of the concept of sustainable urban development as well as the stakeholders and goals in the particular development in North Harbour. Aiding this cognitive learning provided the researcher with an opportunity to reflect on the urban development process and find the aspects that she felt most important to relay. This was helpful in the overall process of the research, as it helped to prepare the researcher for facilitating the workshops and gameplay sessions, where the same information needed to be relayed to the students.

On the other hand, the researcher gained important skills in relation to game design from the collaboration, as working with students with insights and experience into game design as well as the design of the physical manifestation of the game provided an invaluable aid in this aspect.

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Appendices