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Kristian Kiili

## **On Educational Game Design:** Building Blocks of Flow Experience



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**On Educational Game Design:**  
Building Blocks of Flow Experience

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## **Abstract**

The main objective of this research is to study how game design aspects can be integrated with relevant learning theories in educational games in order to develop games that are both engaging and educative. The design-science framework was employed to construct an experiential gaming model answering to this problem. This research is based on reviews of literature, the design of educational materials, as well as empirical studies. The empirical studies, including both quantitative and qualitative data analysis methods, were conducted in controlled situations during the years 2002-2005. All the materials described in this thesis were developed especially for research purposes in order to ensure that attention could be focused on certain aspects of the phenomenon studied.

The thesis presents the construction process of an experiential gaming model that can be used to design and study educational games. The research was carried out in two phases related to two basic activities of design-science, building and evaluating. First, an experiential gaming model was constructed by combining existing knowledge. The aim of the model was to describe the mechanism of learning with games by integrating pedagogical aspects into the design process. Furthermore, the meaning of flow theory, that can be considered as a universal model of enjoyment, was emphasized as a design principle. The experiential gaming model was used to design and implement an educational content management game called IT-Emperor. The evaluation results of IT-Emperor indicated that the experiential gaming model was useful as a design framework, but needed to be revised to better answer the needs of game designers. The final state of this research was reached when the flow antecedents of the revised experiential gaming model were validated through two problem-solving games.

This research indicate that flow antecedents that should be considered in educational game design are: challenges matched to a player's skill level, clear goals, unambiguous feedback, a sense of control, playability, gamefulness and a frame story. Further, the results supported the assumption that concentration, time distortion, autotelic experience, and loss of self-consciousness dimensions can be considered as being indicators of flow experience which has a positive impact on learning. As a conclusion, this research has shown that a game design model that takes both pedagogical and game design aspects into consideration, as well as ways of facilitating the experiences of players, could be constructed. The model does not provide a simple recipe for designing effective educational games, but it surely helps to refine the design of successful ones. The overall benefit of the experiential gaming model is in developing fast, low budget educational games that are educative while still engaging and rewarding.

## Preface

This thesis is based on work carried out during the years 2002-2005. The oldest parts of the thesis were conducted when I started as a researcher at the Tampere University of Technology, Pori. However, in that time I did not have a clue what the scope of my thesis would be. In fact, the subject of my thesis has changed dramatically at least three times during this project. The main studies of the thesis were conducted after the year 2004 when I finally changed the subject to educational game design.

Today, it is time to thank several people who have contributed to my work in many ways. First of all I wish to express my deep gratitude to my supervising professor, Dr. Jari Multisilta, who guided my research work and had faith in me, although it took some time to crystallize my research interest. I am also grateful to him for providing me with excellent facilities for work in his laboratory, the Advanced Multimedia Center at the Tampere University of Technology, Pori. I would also like to thank my second supervisor, Docent Harri Ketamo, who has guided my work and provided new insights into my thesis. Furthermore, I am grateful to him for the co-operation on our usability studies.

I wish to thank Kai Ojansuu who has worked as a game programming specialist in games studied in this thesis, as well as colleagues, Researcher Heikki Haaparanta, Researcher Marko Suominen, Dr. Jyrki Suomala and Dr. Timo Lainema who have provided constructive comments on articles included in this thesis. Additionally, I am grateful to all the personnel in the Advanced Multimedia Center. I would also like to take this opportunity to thank class teachers Ville Tuominen, Antti Päiviö, Saku Holmqvist, and Timo Kainulainen who enabled the empirical studies related to Article 2. I want to emphasize the contribution of Ville ‘*Sauvakävelijä*’ Tuominen as my ‘*mentor*’ during these years.

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**Sätkyllä**

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## List of Articles

This thesis is based on the following six articles.

### ***Article I***

Kiili, K. (2005). Digital Game-based Learning: Towards an Experiential Gaming Model. *The Internet and Higher Education*, 8(1), 13-24.

### ***Article II***

Kiili, K. (2006). Towards a Participatory Multimedia Learning Model. *Education and Information Technologies*, 11(1).

### ***Article III***

Kiili, K. & Ojansuu, K. (2005). Emperor: Game Engine for Educational Management Games. In proceedings of ED-MEDIA 2005, June 27-July 2, Montreal, pp. 1775-1782.

### ***Article IV***

Kiili, K. (2005). Content Creation Challenges and Flow Experience in Educational Games: The IT-Emperor Case. *The Internet and Higher Education*, 8(3), 183-198.

### ***Article V***

Kiili, K. & Ketamo, H. (2005). Optimizing Flow Experience in Web-based Math Refresher Course. In proceedings of ED-MEDIA 2005, June 27-July 2, Montreal, pp. 1783-1790.

### ***Article VI***

Kiili, K. (Submitted to Human Technology). Evaluations on Experiential Gaming Model.

## **PART ONE: INTRODUCTION AND OVERVIEW**

# 1 Introduction

## 1.1 Background

Today information and communication technology is a fundamental part of human activities and it should always be considered within the context of human experience. According to Saariluoma (2005) this basic credo forms the foundation for the concept of *human technology* which aims to explore and understand how humanist and social research can contribute to the conceptualization and implementation of technology. In fact, human technology is a multidisciplinary field that does not have any single theoretical approach that could be applied to all the problems related to human technology. Thus, a multidisciplinary approach in human technology research is imperative.

In fact, this is a multidisciplinary thesis on educational technology, education and psychology dealing with digital learning materials. To be more precise, this is about educational gaming and the development of digital educational games. Generally, information and communication technology has developed substantially since the first pedagogically designed learning materials such as Matrix Algebra (Multisilta, 1996) were implemented in 1994. Although current learning environments support collaboration, for example, most of them still too much resemble books that have been transformed into a digital format and do not utilize the possibilities that new technology provides. However, neither the approach reflecting mere technological achievements is appropriate. Instead designers of learning environments should take a more user-centered approach and aim to facilitate the studying experiences of students. In this thesis user-centered design is understood as being a philosophy that places the user at the center of the design process. According to Ermi and Mäyrä (2005a), player-centered game design is not about asking potential players what kind of game they would like to have, but rather a way of providing the design team with information on what the game design can be based upon and inspired by. The educational game design model constructed in this thesis is founded on this player-centered approach.

In fact, one of the challenges of designing Web-based learning materials is that of engaging students. Hosting a Web-based course should not just be about providing information but also about facilitating students' experiences. Unfortunately, it seems that the Web is mainly used as an information distribution channel that neglects the needs of students. To achieve the attention of students, new ways to utilize computers must be found. The use of technology alone does not motivate students that have lived in the midst of technology all their lives. Thus, learning situations and methods that engage learners

must be created. One approach is to introduce online computer games in education. According to Prensky (2001), educational computer games may create a new learning culture that corresponds better to the habits and interests of students. The claim of Huizinga (1944/1980), arguing that play is not a peripheral and inconsequential activity which is confined for the most part to the sphere of childhood, but rather is the source of civilization, and therefore is central to culture itself, underpins the thought of Prensky. However, the utilization of computer games in education has aroused a raging debate about their suitability and acceptability as educational tools.

Computer games are quite a new form of media invented in the 1960's, referring to a game called Spacewar, (Huhtamo & Kangas, 2002; Saloniemi-Pasternak, 2005) but today they have already established themselves as an everyday phenomenon. Digital games, and their possible effects on players, have been studied in many fields of academic literature ranging from studies on aggression and violence (Cooper & Mackie, 1986; Sherry, 2001; Funk et al., 2002; Gentile, Lynch, Linder, & Walsh, 2004) to educational tools (Kafai, 1995; Kutnick, 1997; Thomas, Cahill & Santilli, 1997; Din & Calao, 2001; Lainema & Hilmola, 2005; Merchant, 2004; Moreno & Mayer, 2005; Vahtivuori-Hänninen, Lehtonen & Torkkeli, 2005).

From a research point of view, the most important game research field is utility games (Kangas, 2003) also referred to as serious games. Utility games refer to games that extend the traditional entertainment game market by contributing to fields of training, policy exploration, education, healthcare etc. Recently, Kangas and Hämäläinen (2004) proposed a game type definition for utility games focusing on educational games in particular. However, their definition that is based on Bloom's taxonomy is inconsistent with Bloom's original ideas. For example, Kangas and Hämäläinen (2004) draw a parallel between games played with fingers and Bloom's cognitive dimension which can be associated with knowledge construction and the development of intellectual skills. Probably, the conflicts have arisen from an endeavor to integrate Bloom's taxonomy with different types of user interfaces. In any event, the game type definition of utility games is not applicable in this research. However, Kangas (2003) argued earlier that captology, referring to persuasive technology, is closely related to the designing of utility games. Captology based game design aims to persuade players to change their attitudes or behaviours in certain determined ways. For example, Health-Hero video games are designed to persuade players to develop good health habits (Fogg, 1998). Thus, the research presented in this thesis also contributes to captology research.

Although, computer games have been utilized in educational settings as persuasive technology since they were invented, no universal definition of games designed for educational purposes exists. In the beginning of the 1990's educational games were called *edutainment* (Kangas & Hämäläinen, 2004; Perrone, Clark & Reppenning, 1996; Okan,

2003; Lyytinen, 2004), because they combined education and entertainment. Later in the same decade the terms edugames and edugaming (education + games/gaming) were introduced (Kangas & Hämäläinen, 2004). However, none of the terms presented have become very popular in educational technology literature. Thus, in this research, the games designed for educational purposes are called simply *educational games* that are understood to be games designed to support the studying and learning ambitions of players, rather than merely being entertaining. The research presented in this thesis concentrates on educational games aspiring to knowledge construction and understanding.

Generally, games satisfy the basic requirements of learning environments identified by Norman (1993) and can provide engaging environments for learning. Traditionally, games are equated with having fun. However, the fun factor is not the key to successful educational game design. The promise of educational games is to engage and motivate players through direct experiences with the game world geared to a certain context. Games should provide possibilities for reflectively exploring phenomena, testing hypotheses and constructing knowledge. Unfortunately, games have been used in education primarily as tools for supporting the practice of factual information. In fact, it can be argued that most educational games too closely resemble digital exercise books and do not utilize the powerfulness of games as an interactive context-free media. The reason for this may be that the field of educational technology lacks research on how to design game environments that foster knowledge construction, deepen understanding (Moreno & Mayer, 2005) and problem-solving while being engaging and entertaining at the same time. This thesis emphasizes the need for the integration of relevant educational theories and game design aspects in order to be able to design engaging, meaningful educational games.

The main purpose of this thesis is to present an experiential gaming model describing the learning process through games, while emphasizing the meaning of flow experience (Csikszentmihalyi, 1975) as a design principle. The most important learning theories applied in this model are experiential learning, constructivism and cognitive load theory. All of these theories have been already utilized in educational game design to some extent, but in the experiential gaming model they are combined into a meaningful entity and linked to game design aspects.

The experiential gaming model stresses the importance of considering flow theory (Csikszentmihalyi, 1975) in game design in order to generate optimal learning experiences for players. Flow describes a state of complete absorption or engagement in an activity (Csikszentmihalyi, 1991). During optimal experience, a person is in a psychological state where he or she is so involved with the goal driven activity that nothing else seems to matter. Flow theory has been utilized in countless studies ranging from quality of life (Csikszentmihalyi, 1991) to sports (Jackson, 1992) but only a few

studies concerning games have been found (Järvinen, Heliö & Mäyrä, 2002; Johnson & Wiles, 2003; Hsu & Lu, 2004; Latva, 2004; Lee and Kwon, 2005; Sweetser & Wyeth, 2005; Ermi, Heliö & Mäyrä, 2004). Studies considering flow as a design framework in educational games could not be found. This was surprising, because past research shows that the flow state has a positive impact on learning, exploratory behavior and attitudes (Webster, Trevino & Ryan, 1993, Ghani, 1991; Skadberg & Kimmel, 2004) and thus this should be taken into account when designing educational games. Although flow theory has not been utilized for game design purposes, similar approaches have been used. For example Quinn (1994) applied the elements of fun (Malone, 1981) in his game design model. Quinn's model includes several important game design aspects, but the elements of fun are not an adequate design approach for educational games -or at least authentic ones. On the other hand, flow theory provides a universal model of enjoyment that is common to all when experiencing enjoyment (Sweetser & Wyeth, 2005).

Because the flow experience plays a fundamental role in this thesis it is important to have a subjective conception of how it feels to experience it. The following imagination exercise (Jacson & Csikszentmihalyi, 1999, 8) is designed to help understand the flow phenomenon.

*“Think of a time when you were totally involved in what you were doing- a time when you felt strong and positive, not worried about yourself or about failing. Describe the situation as fully as possible: when and where it occurred, who you were with, what was happening leading up to this time, and how the experience started. As you recall your experience, use as many senses as you can to imagine the event. Jot down the thoughts, feelings, and impressions of the experience, including how you felt after it was over.”*

Experiencing the involvement related to flow depends on individuals. Some people experience flow often; others, on the other hand, rarely. Additionally, the actions leading to the flow experience vary among people. It is important to notice that the optimal experience usually occurs when a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile. Thus, educational gaming doesn't need to be easy and effortless in order to support the flow experience leading to states of enjoyment. On the contrary, educational games should stretch a player's mind to its limits in an effort to overcome worthwhile challenges. This nature of flow supports the premise of using flow as a design approach in educational game design.

## **1.2 Motivation for the Research**

The theme of this thesis has taken shape over the last four years. The author became interested in digital learning materials when he was studying at the University of Turku. During that time the author took part in some distance learning courses that were quite

disappointing due to the poor quality of learning materials used. Confusing learning experiences motivated the author to do his master's thesis about mLearning, concentrating on usability issues in particular (Kiili, 2002a; Päiviö, Kiili & Ketamo, 2001). The author assumed that good usability would be an adequate approach to facilitating the studying experiences of students. Later on he tried to construct a usability evaluation tool for digital learning environments (Kiili, 2002b). During this work the author became familiarized with the cognitive load theory and his research interests shifted from usability to adaptive navigation (Ketamo, Kiili, Haaparanta & Kempainen, 2004) and multimedia learning. At the same time the author started to teach multimedia programming and he created a simple educational game, *Hacker Attack*, for studying a foreign language. The game creation process turned the author's thesis project upside down once again. As a result, the theme changed to educational games.

Although *Hacker Attack* was an arcade game that was based on repetition, it worked as a trigger for the consideration of the fundamental elements of games. Soon the author became aware that the field of educational technology lacked research on how to design game environments that foster knowledge construction and facilitate the experiences of students. The author spent hours and hours considering how to create learning experiences for students that produce the engagement and pleasure of successful entertainment games. Finally, the author found a theoretical basis for this dilemma in the form of flow theory which, in fact, provided a favorable framework for combining several of the author's research interests. Although many of the original ideas have changed during this thesis project, the main motivation has remained the same: to provide students with digital learning materials that are both effective and enjoyable. So, keep on reading and go with the flow.

## **1.3 Research Objectives and Approach**

### **1.3.1 Research objectives**

The main objective of this research is to study how game design aspects can be integrated with relevant learning theories in educational games in order to develop games that are both engaging and educative. This endeavour is significant because educational technology research is shy of models that successfully integrate these aspects. Such lack has been expressed as a construction of mostly drill-and-practice games that do not usually support reflective thinking and knowledge construction. However, the major flaw in the research of educational games is the neglect of flow theory (Csikszentmihalyi, 1975) as a design principle that can be considered as being one of the key factors for engaging and pleasurable activity. Thus, in this thesis, an educational game design model has been constructed that forms a theoretical basis for game-based learning, as well as works as a

design framework emphasizing the meaning of flow experience. This experiential gaming model enables a shift from behavioristically oriented games aiming for automatization and training of declarative knowledge to engaging games emphasizing creative problem-solving, knowledge construction, understanding and application of information.

The author wants to stress that the proposed experiential gaming model does not aim to provide a simple recipe for designing effective educational games, but surely it will facilitate the design of successful ones. In the terms of van Aken (2004), the elements included in the experiential gaming model can be regarded as working like chunks consisting of heuristic prescriptions. The following describes the logic of prescription: If one wants to achieve Y in situation Z, then something like action X will help. Something X can be regarded as a design exemplar, which is a general prescription which has to be translated to the given problem at hand. In other words, a designer has to design a specific variant of a design exemplar in order to fix the design decision to a certain context. In addition to the experiential gaming model, this research also concentrates on producing design exemplars for utilization in educational game design.

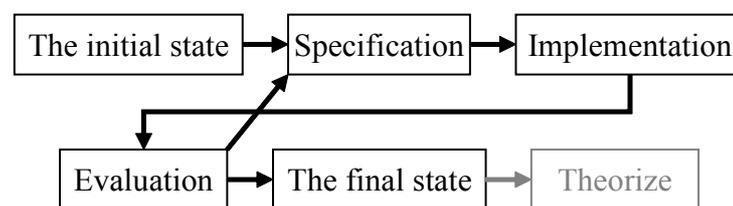
Furthermore, during this research new knowledge about educational games and user experience has been attained. Generally, the research also contributes to learning environment design by stressing the importance of facilitating the educational experience of learners. Since the flow experience has a positive impact on learning, attitudes and exploratory behaviour (Webster et al., 1993, Ghani, 1991; Skadberg & Kimmel, 2004), it should be used as a design principle more widely in different contexts.

### **1.3.2 The Research Approach**

This research was carried out in two phases related to two basic activities of design-science: building and evaluating (March & Smith, 1995). In this thesis design-science is equated with constructive research. According to Järvinen (2004), the purpose of the building process is to achieve movement from the initial state to the final state. The initial state is the starting point of an effort to construct a new artifact reflecting the final state. In this thesis the term artifact is used to describe something that is human constructed (Lainema, 2003). March and Smith (1995) distinguished four types of artifacts: constructs (vocabulary of a domain), models (propositions expressing relationships among constructs), methods (algorithms or guidelines), and instantiations (realizations of artifacts). According to this classification, the main outcomes of this study are vocabulary on educational gaming, the experiential gaming model and the instantiation, IT-Emperor. However, unlike March and Smith (1995), van Aken (2004) does not consider instantiation as an outcome of the design-science study, but maintains that its ultimate mission is to develop knowledge that can be used in designing solutions to problems. Thus, the main focus of this thesis is in developing the experiential gaming model and

related design knowledge. Nevertheless, the author subscribes to the classification of March and Smith (1995).

Figure 1 illustrates the movement from the initial state to the final state. In this research an experiential gaming model related to a specification stage (Article 1) was formed by combining existing knowledge. This model was used to design and implement an educational game called IT-Emperor (Article 3). IT-Emperor was evaluated and these evaluation results were used to revise the experiential gaming model. The final state was reached when the flow antecedents of this revised experiential gaming model were validated through two problem-solving games (Article 6).



#### 1. Movement from the initial state to the final state

As a final remark, the author wants to emphasize that the fundamental purpose of the constructed games was to provide a means to evaluate and further develop the experiential gaming model which reflects the main outcome of this thesis. The long term goal is to theorize the constructed experiential gaming model. As shown, this research has followed a design-science approach, although the research project in its entirety is still in early stages. In order to be able to theorize the experiential gaming model, several iterations on design and evaluation stages have to be conducted. However, the work presented in this thesis also provides a framework for other researchers to test and validate the experiential gaming model.

### 1.3.3 Measuring Methods for Flow Experience

Flow has been studied in previous research using several methods. These methods can be divided into two main approaches.

1. The Activity-Measurement Method: Participants are involved in a selected activity. After that they are interviewed or asked to evaluate their experience with that activity using a survey instrument (for example, Webster et al., 1993; Ghani & Deshpande, 1994; Pilke, 2004; Skadberg & Kimmel, 2004).
2. The Experience Sampling Method (ESM) is used to gather information during certain activities. In the ESM participants are paged throughout the day for a certain period of time. When paged, participants evaluate their activity using a survey instrument (for

example, Csikszentmihalyi, Larson & Prescott, 1997; Csikszentmihalyi & LeFevre, 1989; Csikszentmihalyi & Nakamura, 1989; Havitz & Mannell, 2005).

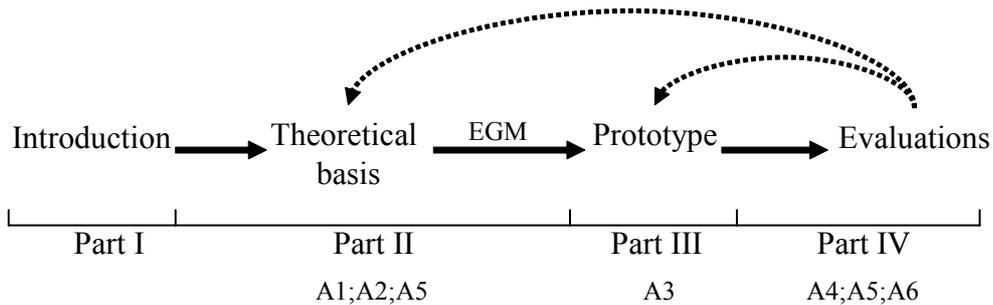
An important question in the first approach is whether respondents can reliably evaluate flow after, rather than during, an activity. On the other hand, the ESM can be criticized for interrupting a participant's experience and normal behaviour, which may decrease the ecological validity of the study (Loomis & Blascovich, 1999), although the measurement activity is situated. However, it is apparent that different interventions and contexts require different methods for use.

The first approach was selected in this research for the following reasons. First of all, IT-Emperor is a distributed game environment (consisting of actual IT-Emperor application, content creation applications, the Internet and university's library) and thus ESM would have been hard to implement reasonably. Secondly, repetitive measuring interventions would have disturbed the players' playing experiences and overloaded the players' workload too much. Thirdly, the ESM method is not an appropriate approach for short interventions like the small problem-solving games utilized in Article 6.

Although, the playing experiences of IT-Emperor were studied via interviews and questionnaires, the emphasis was on interviews due to the small sample size and simplified questionnaire used (Appendix 1). However, the problem solving games studied in Article 6 were evaluated based solely on questionnaires (presented in Article 6). The approach used partially resembles the playtest method proposed by Davis, Steury and Pagulayan (2005). The playtest method combines traditional, scientific survey methods with a controlled laboratory environment to collect systematic, quantitative information about players' perceptions of games. The difference between the playtest method to the approach used in this research is that players did not play in a controlled laboratory environment, but their behaviour was observed virtually. Furthermore, the emphasis was on flow experience, not on the main game elements.

## 1.4 The Structure of the Thesis

The thesis is divided into four main parts as illustrated in Figure 2. The figure also illustrates the relationship between included articles and different parts of the thesis. Part 1, i.e. this part, provides an introduction to the topic and to this thesis. Relevant background knowledge, motivation for the research, research problems and structure of the thesis are presented in this part. Additionally, an overview of articles included is briefly described.



### 2. Relationships between different parts of the thesis (A = Article)

Part II forms the theoretical basis for constructing a prototype, IT-Emperor. First, relevant theories and studies are presented in order to construct the Experiential Gaming Model (EGM) that is finally presented at the end of part II. The experiential gaming model is the main input of part III, which presents the educational game, IT-Emperor, designed according to the experiential gaming model. In the last part, the experiential gaming model is evaluated and validated through experiments on IT-Emperor and two problem-solving games. The evaluation results of IT-Emperor are used to revise the experiential gaming model concerned as the main outcome of this thesis. Generally, in part IV all the threads are gathered together and conclusions are summarized.

## **2 Overview of Articles**

This section briefly describes the research objectives and methods of the six articles attached to this thesis, and declares their logical interrelationships that are not self-evident in the articles themselves. Additionally, the division of labour of the co-authored articles is clarified. Three of the included articles were published in journals, two in conference proceedings, and one article was submitted to a journal.

### **2.1 Article I: “Digital Game-Based Learning: Towards an Experiential Gaming Model”**

**Kiili, K.** (2005). Digital Game-based Learning: Towards an Experiential Gaming Model. *The Internet and Higher Education*, 8(1), 13-24.

The primary intention of the first article is to tackle the problem of how to design educational games that are based on both educational theories and game design aspects. As a result, the article presents an experiential gaming model that was constructed with the help of analogical reasoning by utilizing existing knowledge. The model links gameplay aspects with experiential learning in order to facilitate the flow experience. The ambition of designing games that enhance the experience of flow is justifiable because previous research has indicated that flow has a positive impact on learning, exploratory behaviour and players’ attitudes (Webster et al., 1993, Ghani, 1991; Skadberg & Kimmel, 2004). It is apparent that flow experience cannot be guaranteed to players, but educational games that provide the possibility of experiencing flow certainly can be provided. The focus of the article is not on the precise moments of the flow experience itself, but on the factors contributing to the flow experience for the purpose of maximizing the impact of educational games. The proposed experiential gaming model can be used to design and analyze educational games. However, the model works only as a link between educational theory and game design and does not provide the means for a whole game design project. In general, this article forms the core of the thesis and other articles included are based upon this one.

### **2.2 Article II: “Towards a Participatory Multimedia Learning Model”**

**Kiili, K.** (2006). Towards a Participatory Multimedia Learning Model. *Education and Information Technologies*, 11 (1).

The purpose of this article is to present a participatory multimedia learning model that can be used in designing multimedia learning environments that support an active learning process and creative participation by students. Participatory multimedia learning can be defined as being learning with systems that enable learners to produce part of the learning materials themselves. The aim of the model is to represent the human information processing system and to support the transformation of free cognitive resources to a germane cognitive load needed for knowledge construction. The article also presents the results of an empirical study that examines the effectiveness of student-generated illustrations and animations.

**Research Methods:** The participants were 10-12 year old Finnish elementary school pupils (N=187). The computer-based learning materials consisted of three versions of multimedia material and text-only material designed to teach pupils how the human immune system works. The text version (n=37) consisted of basic text that describes how bacterium attack the human body and how different white blood cells fight against them. The basic text was also included in the multimedia versions and was presented on the right hand side of the screen. There were two versions, a drawing version and a dragging version, where pupils self-generated illustrations of the learning material. In the drawing version five drawing tasks opened on the left hand side of the screen. Pupils (n = 39) were asked to draw five illustrations of certain subjects, based on the text. A simple drawing program was embedded into the learning material. The drawing group had three minutes time to complete each drawing. In the dragging version pupils (n = 49) were asked to construct five illustrations of certain subjects by dragging objects onto the stage. The dragging group had two minutes time to form each illustration. An animated version (n = 44) consisted of seven short animations synchronized with audio narrations that opened on the left hand side of the screen. The animations used were very simplified representations of subject matter. The pupils in the control group (n = 28) did not have any additional educational aides and were used to measure the learning effect of the test questionnaire. All learning materials were constructed using Flash MX.

The digital questionnaire used in both the pre-test and the post-test consisted of six open questions (Appendix 2). All questions measured subjects that both the animation and drawing/dragging tasks dealt with. First, participants filled out the pre-test questionnaire. Secondly, the experimenter provided instructions as to how the different multimedia materials were to be used. After the learning session, which took approximately 20 minutes, participants had 15 minutes to fill out the post-test questionnaire. The mean scores and standard deviations of the pre-test and post-test were calculated depending on treatment types. In addition, the improvement percentage of each group was calculated from the primary score by subtracting the pre-test score from the post-test score and then dividing the difference by the pre-test score. In order to find out the differences between

the educational treatment types, the improvement scores were compared using a T-test. In addition the sizes of the effect were calculated.

**The Relationship to the Whole:** The theoretical part of the article provides an overview of the human information processing system. Such knowledge is necessary to be able to understand the schema construction process of experiential gaming model and the utilization of multimedia elements in games in general. The paper discusses the relationship between multiple presentations and cognitive load theory and aims to form an account for participatory multimedia learning. The empirical study conducted examines the usefulness of participatory multimedia learning tasks and the effectiveness of animations used in non-interactive parts of games. To conclude, the main relationship to the whole thesis is to construct a basis for content creation challenges, (i.e. participatory multimedia learning tasks), that are the main challenge type in the game, IT-Emperor.

### **2.3 Article III: “Emperor: A Game Engine for Educational Management Games”**

**Kiili, K. & Ojansuu, K. (2005).** Emperor: Game Engine for Educational Management Games. In proceedings of ED-MEDIA 2005, June 27-July 2, Montreal, pp. 1775-1782.

The main purpose of this article is to introduce a dynamic game engine called Emperor. Emperor is designed to construct and run educational content management games. To overcome a resource shortage, Emperor was implemented so that it can be easily utilized in different contexts. In its first period Emperor was selected to rule a Web-based usability game called IT-Emperor. Articles 1-2 provide the theoretical background upon which both these instantiations are based. In a way this article provides the means (IT-Emperor) to study the usefulness of an experiential gaming model. This evaluation was conducted through an empirical study on IT-Emperor that is also briefly presented in this article. However, the methods used and results achieved are discussed more extensively in Article 4.

### **2.4 Article IV: “Content Creation Challenges and Flow Experience in Educational Games: The IT-Emperor Case”**

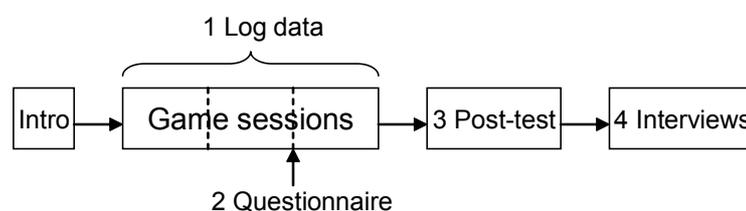
**Kiili, K. (2005).** Content Creation Challenges and Flow Experience in Educational Games: The IT-Emperor Case. *The Internet and Higher Education*, 8(3), 183-198.

In this article, the experiences of university students (n =18) playing an educational game, IT-Emperor, which was designed to facilitate flow experience, are studied. The main purpose of this article is to study the usefulness of content creation challenges included in IT-Emperor and factors that have an influence on flow experience. Following is a short description of IT-Emperor and research methods used. A more detailed description of IT-Emperor can be found in Section 7.

**Research Methods:** IT-Emperor is a Web-based educational game where university level students work in a virtual production company as trainees. Players are hired to produce learning material about usability. The content of the game reflects the problems and issues that may arise in a production company. Generally, the aim of the players is to produce the best possible learning material and, at the same time, earn money in the marketplace. The outcomes of the usability project, learning material and a banking balance are used to decide what kind of job the trainee will achieve in the company.

The participants were eighteen Finnish university students that had enrolled in a usability course where IT-Emperor was played. Most of the participants were students of Tampere University of Technology, but there were also one student from the Turku College of Economics and Business Administration and two students from the Open University. All participants had used the Web for over five years and reported using the Web daily. There was only one female in the course. Thus, because of the small sample size and biased gender breakdown, these independent variables could not be used in analysis without revealing the participant’s identity.

Figure 3 shows the procedure and data collection of the study. In the introduction section the idea, as well as the user interface of IT-Emperor, was presented to participants. The game lasted over two months and it took approximately 30 hours to complete the game. In order to boost the progress of the game it was divided into three phases that reflected status reports used in software projects. Players had to produce and buy components for a certain amount in each phase. The game’s author could follow players’ progress in the game by following status reports.



### 3. Procedure and data collection

The data was collected in four stages. All game activities were observed virtually and recorded on Web-logs. After two months of a playing session an online questionnaire consisting of 13 questions altogether was employed to measure players' experiences related to IT-Emperor (n = 18). The flow antecedents included in the experiential gaming model (Article 1) were measured using seven structured questions that were obtained from a questionnaire designed to measure the flow construct in online environments (Novak, Hoffman & Yung, 2000). Five additional structured questions that measured the previous experience of participants in Web usage and their opinions about IT-Emperor and the usefulness of content creation challenges were included in the same questionnaire. The scales of questions varied from two to four. Additionally, an open text field where participants could write their opinions about IT-Emperor was included. When the game was finished a student's knowledge level was measured with a post-test (n = 15) that was implemented as an exam. The post-test consisted of questions related to lectures, the game and flow experience. The first essay question was a control question that measured knowledge that was presented in lectures and was included in the exam material. The second essay question measured knowledge that was needed to complete the game. In other words, the question measured knowledge about components that players had created during the playing session. Additionally, the following description of flow (Novak et al., 2000) and two questions measuring flow were included in the exam:

*Description of flow: "The word flow is used to describe a state of mind sometimes experienced by people who are deeply involved in some activity. One example of flow is the case where a professional athlete is playing exceptionally well and achieves a state of mind where nothing else matters but the game; they are completely and totally immersed in it. The experience is not exclusive to athletics – many people report this state of mind when playing games, when engaging in hobbies, or working. Activities that lead to flow completely captivate a person for some period of time. When in flow, time may seem to stand still and nothing else seems to matter. Flow may not last for a long time on any particular occasion, but it may come and go over time. Flow has been described as an intrinsically enjoyable experience."*

Thinking about your own use of IT-Emperor and related activities:

- A) Do you think you experienced flow while playing IT-Emperor?
- B) What were the activities that caused a flow experience?

Players' perceptions about experiencing flow while playing IT-Emperor were categorized into three classes; 2) strong flow experience, 1) medium flow experience and 0) no flow experience. These categories are used to study the connection between flow and learning. In this thesis flow is understood as being a continuum rather than as being an on-off state. This is reasonable because Csikszentmihalyi (1991) stated that when people reflect on how they feel when experiencing flow, they mention at least one, but often all the

dimensions distinguished in Section 4.1. Furthermore, flow researchers such as Jackson and Marsh (1996) have developed a flow scale that considers flow to be a sum variable consisting of nine flow dimensions. For that reason it is justified to operationalize flow experience so that it consists of different levels.

Finally, the participants (n = 12) were interviewed in groups of 1-4 participants. Semi-structured interviews concentrated on the following themes: games in education, flow experience and further development of IT-Emperor. Participants were encouraged to talk about their opinions and experiences on all of the topics above. All interviews were recorded and coded using a HyperResearch program. Categories for coding were derived from the flow theory and from the experiential gaming model.

**Relation to the Whole:** This article describes an empirical study that forms the basis for evaluating and further developing the experiential gaming model. Furthermore, it provides general information on educational gaming that broadens the research approach of this thesis.

## **2.5 Article V: “Optimizing Flow Experience in a Web-based Math Refresher Course”**

**Kiili, K. & Ketamo, H. (2005).** Optimizing Flow Experience in Web-based Math Refresher Course. In proceedings of ED-MEDIA 2005, June 27-July 2, Montreal, pp. 1783-1790.

This article shows how the ideas of the experiential gaming model can be utilized in a non-game context. The results of the first implementation of a university level Web-based math refresher course are presented. However, the main focus is on further development of the course system. The purpose of this development is to facilitate the experiences of students in order to maximize the impact of the course. The development scenario presented is based upon the aid of the experiential gaming model and the results of an adaptive geometry game.

**Research Methods:** The article includes two empirical studies. First, the results of an adaptive geometry game study are presented. The results of the game indicate that flow theory can be utilized when designing effective learning solutions. Thus, in order to facilitate the learning experiences of students, adaptation to a user’s skill level in particular will be considered when developing the second version of the Math Refresher course. Secondly, the results gathered from the first version of the Math Refresher course are presented in order to be able to form the basis of the redesigned Math Refresher course. Because the two empirical studies of this jointly written article are mainly

Ketamo's work, the emphasis is on the design activities of the new system which is the author's contribution to this article.

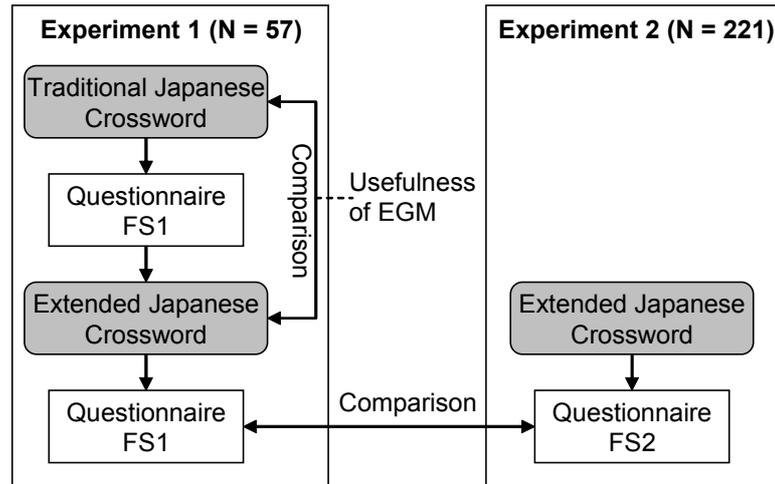
**Relationship to the Whole:** In some way this article stands out from the others because the relationship to IT-Emperor is quite tenuous. However, the article is included because it provides an important view on adaptivity as a flow inducing feature that should be considered in educational game design. Adaptation to a player's skill level was not implemented into IT-Emperor because of the ill-structured nature of content creation challenges. However, in contents like the geometry game, an adaptive system can be implemented. Furthermore, this article also provides an example of how the ideas of an experiential gaming model can be utilized in non-game contexts.

## **2.6 Article VI: "Evaluations of an Experiential Gaming Model"**

**Kiili, K.** (Submitted to Human Technology). Evaluations on Experiential Gaming Model.

In this article, the experiences of players of two problem-solving games are studied. The main purpose of this article is to validate the flow antecedents included in the experiential gaming model and to study their influence on flow experience. Additionally, the study aims to operationalize the flow construct in an educational game context and to start a scale development process in order to assess flow experience in game settings. Following is a short description of games and research methods used. More detailed description of games and questionnaires can be found in Article 6.

**Research Methods:** The problem-solving games used in this study are based on Japanese crosswords, which are puzzles also known as nonograms, griddlers and paint-by-numbers. The puzzle genre was selected because solving mental puzzles is one of the oldest forms of enjoyable activities (Csikszentmihalyi, 1991). Generally, the aim of the player working on a Japanese crossword is to solve and open the image encrypted with numbers. This study consisted of two experiments as illustrated in Figure 4.



#### 4. The research design of the study (EGM = Experiential Gaming Model)

In Experiment 1 the usefulness of the experiential gaming model in extending a traditional Japanese crossword to a more gameful entity was studied. Participants (N = 57) were recruited from university students and employees by email. The study materials were freely accessible on the Web. The Flow Scale 1 (FS1), which uses a 5-point Likert-type response format (5 = agree to 1 = disagree), consisted of the following nine dimensions: 1) challenge, 2) goal, 3) feedback, 4) control, 5) playability, 6) frame story, 7) concentration, 8) time distortion, and 9) autotelic experience. Additionally, there were a few open-ended questions as well as a question to measure flow experience directly, which can be considered as a control question. The FS1 was self constructed. The mean scores of each question were calculated. In order to find out the differences between games 1 and 2, the question scores were compared using a T-test. The reliability of the questionnaire was calculated using Cronbach's alpha estimates. However, if the dimension consisted of only two items, reliability was estimated using correlation. In addition, correlation was used to study the uniformity of the questionnaire in different contexts (Game 1 and Game 2) along with the relationship between flow antecedents and flow experience.

Experiment 2 differed in two ways from Experiment 1. First of all, only the extended Japanese crossword was used to study the experiential gaming model and the gaming experiences of players. Secondly, the questionnaire was changed from a self-made one to an already validated one. The Flow Scale 2 (FS2) was condensed and contextualized from FSS developed by Jackson and Marsh (1996). The 5-point Likert-type response format (5 = agree to 1 = disagree) consisted of all nine dimensions that Csikszentmihalyi outlined. Additionally, there were a few open-ended questions and a question directly measuring flow experience, which can be considered as a control question. Participants (n = 221) were recruited from university students and employees with email as in Experiment 1. The study materials were on the Web and could be accessed freely. The mean scores of

each question were calculated. The reliability of the questionnaire was calculated using Cronbach's alpha estimates and correlations. In addition, the correlation was used to study the relationship between flow antecedents and flow experience.

**Relation to the Whole:** This article describes two empirical experiments that are used to validate most of the flow antecedents included in the experiential gaming model. The study operationalizes the flow construct in an educational game context and starts a scale development process to assess flow experience in game settings. Thus, it provides tools that can be utilized in the reflective evaluation phase of the game design cycle.

## **2.7 Concerning Joint Articles**

The author has attempted to reduce the problems that joint articles inherently cause in a doctoral thesis by selecting articles where the author of this thesis is the main author, or his contribution has been substantial. As a result, three journal articles where the only author has been the author of this thesis, as well as two jointly written articles published in conference proceedings and one article sent to a journal (only author) were selected for this thesis.

Article 3 was written with Kai Ojansuu who worked on the Emperor project as a game programming specialist. The core contribution of this article is the author of this thesis' personal research work and this same author was responsible for writing the major part of the article. However, although the undersigned author designed the artifacts presented in this article, discussions with the programmer influenced design decisions.

Article 5 is also a joint article written with Harri Ketamo. Although the undersigned was a responsible author in this article, the empirical studies included are mainly Ketamo's work. The contribution of the author of this thesis was in analyzing the results within a flow framework and redesigning a new course system.

## **PART TWO: THE THEORETICAL BASIS**

### **3 Building Blocks of Experience**

The designers of educational environments should understand that keeping students satisfied is the key to a successful education. The positive experiences of students may encourage students to become engaged in studying activities. Conversely, if the experience does not match expectations, if it is boring, or uninteresting, then it may not hold the students' attention and can potentially shift attention from relevant studying activities to inappropriate ones. A great number of corporations have understood the value of creating positive experiences for their customers. For example, Disney allocates enormous resources to ensure that their theme park visitors are immersed in a fairy-tale world (Fleming, 1998) in order to ensure revisits. Likewise, educators should consider elements that facilitate the experiences of students. However, this aim should not be understood only as being an enterprise to entertain students, but rather to create learning experiences that matter. In this thesis, the flow theory is used as a framework for facilitating educational experiences in a game environment. In order to be able to understand the background of the factors that contribute to flow experience (Csikzentmihalyi, 1975), the elements that constitute an educational experience and user experience have to be distinguished. However, this section starts with presenting the author's conception of the term 'experience' before dealing with educational elements and related issues.

#### **3.1 Breaking Experience Apart**

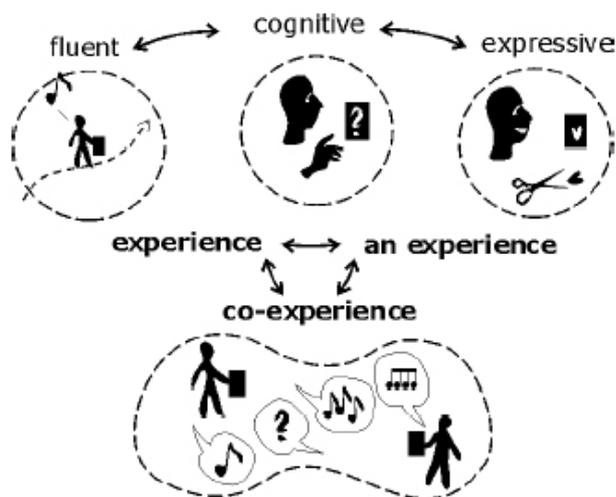
Experience is a core concept in this thesis. The American Heritage Dictionary of the English Language (2000) defines experience as follows: Experience is

*“participation in events or activities, leading to the accumulation of knowledge or skill.”*

The view of Dewey's (1938/1997) is similar: experience is continuous interaction between human beings and their environment. Furthermore, Dewey's theory states that one's present experience arises from the interaction between one's past experiences and the present situation. In other words, the experience now is a result of interplay between the present situation and prior experiences.

In order to be able to draw connections between artifact design attributes and experience, experience needs to be considered more thoroughly. The ideology of Forlizzi's and Battarbee's (2004) interaction-centered framework of experience is a good starting point in this endeavor. The framework focuses on the interaction between individuals and products as well as the experiences that rise from the interaction. The framework

describes user-product interactions (fluent, cognitive, and expressive) and breaks experience down into three dimensions: experience, an experience, and co-experience. Figure 5 illustrates the relationship between different types of product interactions and experiences.



#### 5. The dynamics of experience (Forlizzi & Battarbee, 2004, 264)

Forlizzi and Battarbee (2004) distinguished between fluent, cognitive, and expressive user-product interactions. Fluent interactions are understood as being activities that have been condensed into routines, such as riding a bicycle. In fact, fluent interactions refer to schema automation described in Article 2. In general, information can be processed either consciously or automatically (Winn, 2004). Conscious processing, occurring in working memory, requires conscious effort, but automatic processing mainly bypasses working memory. Automatic processing may occur after sufficient practice and can be carried out with minimal working memory load (Sweller, van Merriënboer & Paas, 1998). For example, experienced chess players can move chessmen without conscious processing of how each chessman can be moved. Furthermore, fluent user-product interactions do not compete for our attention and thinking process, but cognitive resources can be directed to higher order tasks.

In contrast, cognitive user-product interactions refer to activities that require thinking while using a product (Forlizzi & Battarbee, 2004). For example, usage of a new product or an action in a new digital environment requires cognitive effort. From an educational point of view, not all cognitive experiences are undesirable ones. A cognitive experience is an essential premise for learning to take place. In fact, one aim of education is to stimulate learners to process relevant information more deeply. However, inappropriate cognitive processing in educational activities should be cut down in order to assure enough cognitive resources for higher order tasks.

Expressive user-product interactions refer to interactions that help the user to form a relationship with a product, like modifying or personalizing it. In other words, a user aspires to a better fit between himself and a product. On the other hand, interactions may also be expressed as stories about product relationships based on location in context, prior experience, and current emotional state, to make a unique and subjective story of the interaction experience (Forlizzi & Ford, 2000). For example, modifying an old game or personalizing a mobile phone with a background image can be considered as being expressive interactions.

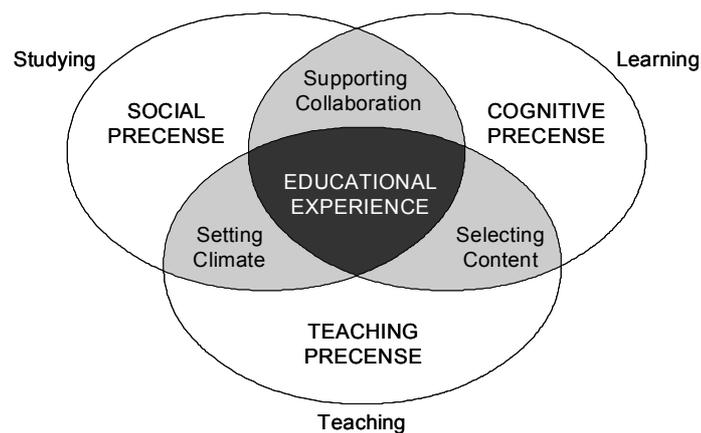
Forlizzi and Battarbee (2004) break experience down into experience, an experience, and co-experience dimensions based on the context they unfold. Experience is constant stream of “self –talk” that happens when interacting with products. It expresses how we assess our goals, the use of products or surrounding environments at any given time. For example, walking in the park can be considered as experience. An experience is more coalesced and it can be articulated. It has a clear starting point and a definitive end. However, the most important characteristic of an experience is that it inspires emotional, cognitive or behavioral change in the experiencer. For example, a lecture can be considered as a typical example of an experience. The last dimension, co-experience, refers to user-interactions experienced in a social context. It is a process where users together contribute to shared experience creating interpretations and meanings from their life contexts and allowing themes and social practices to evolve (Battarbee, 2003a). Information and communication technology can play an important role in supporting co-experience. For example, collaborative games such as IT-Emperor provide a mediated communication channel between players making it possible to create experiences together. Furthermore, Battarbee (2003b) argues that co-experience is creative because people using technology together produce much more creative and interesting results than individual users. Thus, it is reasonable to design collaborative activities into educational games.

Emotion is an essential component in both user-product interactions and user experience (Forlizzi & Battarbee, 2004). It affects how a user perceives the product and interacts with it. Thus, emotion serves as a resource for understanding experiences. According to Forlizzi & Battarbee (2004), emotion helps a user to evaluate outcomes and experiences arising from interactions with products. Authors argue that satisfactory outcomes leading to a reduction of effort or that creation of a new goal supports fluent experience paralleled with a flow state. However, flow theory actually doesn't support this premise. Fluent experiences do not contribute to flow experience which requires the activity to be challenging. If the activity does not require any cognitive or physical effort the user supposedly does not experience flow.

Above the user-product interaction and experience was broken down into components. It is important to be aware of these micro-level components in order to be able to understand users' experiences. However, because experiences emerge in a certain context we have to consider what factors influence experience. According to Forlizzi and Ford (2000), the characteristics of a user, an artifact as well as the context of use and social and cultural factors influence how people experience things. In the next sections factors that influence experience are considered in an educational setting involving technological tools.

### 3.1.1 The Educational Experience

Garrison, Anderson and Archer (2000) identified three elements that are crucial prerequisites for a successful educational experience. These elements, cognitive presence, social presence and teaching presence are outlined in Figure 6. The original model of Garrison et al. (2000) was embedded within a community of inquiry and was used as a framework to study text-based computer conferencing. However, the elements of the model can also be utilized in the context of educational computer games. The first element of the model is a cognitive presence that refers to the ability to construct meaning through action and communication in the game world. It is a vital element in critical thinking and refers to cognitive experiences. The second element of the model is a social presence referring to co-experience that supports a cognitive presence by facilitating the process of critical thinking carried out by the community of players. The third element of the model is a teaching presence that consists of two general functions usually carried out by a teacher or a game administrator as described in Article 4. A teacher designs the educational experience and works as the facilitator of the game.



6. Elements of an educational experience (modified from Garrison et al., 2000, 88).

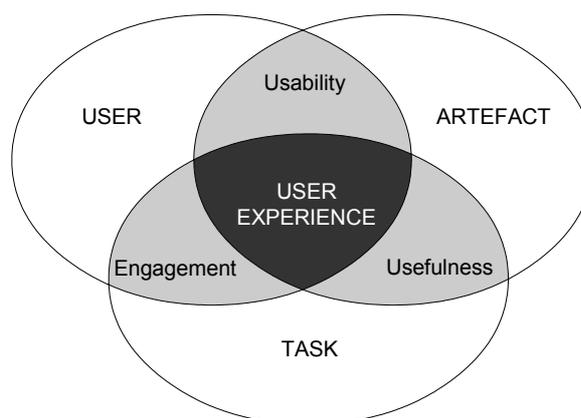
In this thesis, the model is supplemented with a teaching-studying-learning (TSL) process (Uljens, 1997), which underlines the importance of considering all these components. The

TSL process is based on the idea that teaching does not lead directly to learning. A studying component is needed in between these fundamental components. Thus, teaching indirectly influences learning via the learners studying. Studying is situated in the social presence component because current learning theories stress the meaning of social aspects on learning. However, studying can also be an individual activity in a community lacking social interaction. In this thesis, TSL components related to core elements of the model are seen as being a dynamic whole. In different game contexts, the roles of TSL components may vary. Thus, games can be individual, community or teacher oriented, depending on the rules and characteristics of the game that a teacher (game author) has defined. In spite of its emphasis, the aim of education is to facilitate the experiences of students so that students are engaged in activities to enhancing learning.

It is important to realize that even though new technologies, including educational games, have broadened the TSL horizon, they are still just tools that serve the process. However, in computer-mediated environments the technologies used affect how learners experience educational activities. For that reason the model of educational experience needs to be supplemented with a user experience dimension discussed in the next section.

### **3.1.2 User Experience**

Design activity has been embraced in an attempt to “design the user experience”. There has been some effort to create models of user experience (Forlizzi & Ford, 2000; Garret, 2003; Forlizzi & Battarbee, 2004; Pine II and Gilmore, 1998), but the theory of user experience is still quite patchy. However, designers of educational artefacts need to understand how users interact with different types of artefacts and how this interaction affects users’ educational experiences. User experience is usually paralleled to usability. However, usability has been critiqued for not addressing the emotional side of product use enough. Generally, usability aims more at the removal of obstacles than at providing engaging and rewarding experiences. This criticism has ensued from the approach that defines usability from a product-oriented viewpoint, suggesting that usability can be designed into a product. Such an approach considers usability as being ease of use but does not commit to usefulness of the product and quality of use. Thus, more user-oriented and performance-oriented definition is needed. In fact, Bevan and Macleod (1994) used the following definition (ISO 9241-11) that takes these aspects into account: “*The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.*” This broad definition of usability enables a shift of focus from features of products to characteristics and feelings of users. In this thesis usability is considered as being one factor among others that affects user experience. Figure 7 shows the author’s macro-level conception about user experience from individualistic point of view. Although, the format of the user experience illustration is similar to the illustration of educational experience, these dimensions are not meant to be understood as overlapping but parallel.



## 7. Elements of user experience

User experience consists of three main elements: the user, an artefact and a task. User experience emerges from the interplay between these elements. The characteristics of a user, such as emotions, values and prior experience, determine how a user perceives an artefact and the task at hand. Usability of an artefact is determined in the interaction between a user and an artefact. Usefulness refers to the design of an artifact containing the right functions required for users to perform their tasks efficiently and to accomplish their goals (McGrenere & Ho, 2000). Design of an artefact should support a shift from a cognitive product-interaction to a fluent one in order to guarantee enough cognitive resources for relevant information processing. Such a shift often means that the use of an artefact is effortless and easily learned (Forlizzi & Ford, 2000).

However, not all activity in educational environments should be effortless. In fact, a learning task should impose a germane cognitive load that is required for knowledge construction (Article 2). Generally, the way a user perceives a task and an artefact affects user experience. If the task is engaging, the user is willing to use more effort to accomplish the task. Skinner and Belmont's (1993) definition of engagement in educational context can be applied to user experience. According to them, engagement refers to the intensity and emotional quality of a user's involvement in initiating and carrying out activities. Engaged users show sustained behavioral and cognitive involvement in activities accompanied by a positive emotional tone. To summarize, good usability, a useful artefact and an engaging task create prerequisites for a good educational experience. However, it is noteworthy that designers cannot design the subjective experience, only the context may be designed (Battarbee, 2003b).

### **3.2 Putting Experience Back Together**

Although educational experience and user experience were distinguished above, it is important to realize that these dimensions are bound to each other, and in the end their interplay constitutes the experiences of students. Additionally, a context of use and cultural factors also influence how people experience things. In an ideal situation the elements of both dimensions create prerequisites so that experiencing flow (Csikszentmihalyi, 1975) is possible. Next a theory concerning flow experience is presented.

## 4 Flow Experience

According to Forlizzi and Ford (2000), a great deal of existing work on the qualities of experience, centers on either ease of use or pleasantness of products. Flow theory provides a meaningful framework to embody new qualities of experience which are relevant for educational purposes. In fact, past research has shown that the flow state has a positive impact, among others, on learning (Skadberg & Kimmel, 2004) and therefore should be taken into account when designing digital learning materials, including games. Csikszentmihalyi (1975) introduced the flow state through a study of people involved in activities such as rock climbing, chess and dance. Flow describes a state of complete absorption or engagement in an activity and refers to the optimal experience (Csikszentmihalyi, 1991). During optimal experience, a person is in a psychological state where he or she is so involved with the goal driven activity that nothing else seems to matter.

### 4.1 Roots of the Flow Experience

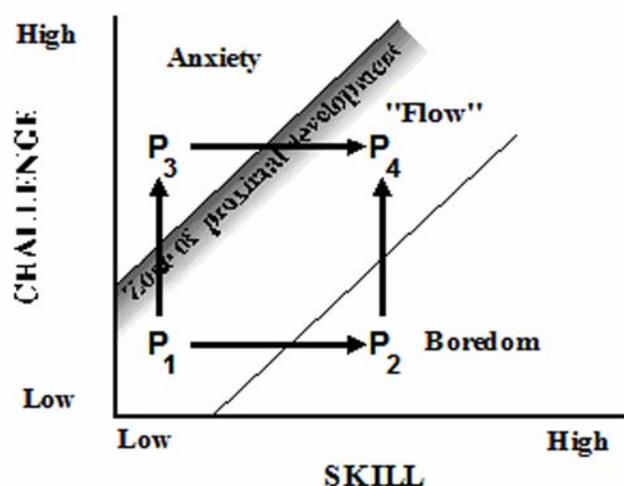
In Csikszentmihalyi's (1975) early work people were identified as experiencing flow through interviews and questionnaires about specific activities. Csikszentmihalyi (1991) defined the phenomena of flow state as having eight dimensions: (1) clear goals, (2) immediate feedback, (3) personal skills well suited to given challenges, (4) merging of action and awareness, (5) concentration on the task at hand, (6) sense of potential control, (7) a loss of self-consciousness, and (8) an altered sense of time. The concept of autotelic experience that describes the rewardness of the activity can be regarded as the ninth dimension. When people reflect on how they feel when their experience is most positive, they mention at least one, and often all, of the dimensions. The combination of these elements causes a sense of deep enjoyment that is so rewarding that expanding a great deal of energy is worthwhile to be able to feel it (Csikszentmihalyi, 1991). An activity that produces such experiences is so pleasant that a person may be willing to do something for its own sake without being concerned with what he will get out of the action. The dimensions are defined in Article 6.

The important question is how do such experiences happen? Furthermore, why are some activities boring, but others are enjoyable? According to Csikszentmihalyi (1991) research has pointed out that every flow activity had the following in common:

*“It provided a sense of discovery, a creative feeling of transporting the person into a new reality. It pushed the person to higher levels of performance, and led to previously*

*undreamed of states of consciousness. In short, it transformed the self by making it more complex. In this growth of the self lies the key to flow activities."*

Csikszentmihalyi (1991) explained this finding with a diagram (Figure 8) that is referred to as a three channel model of flow. The following is an explanation of this diagram (The diagram is explained in Article 4 in the context of IT-Emperor.). Challenges and skills that are theoretically the most important dimensions of experience are represented on the axes of the diagram. The letter P represents a person playing snooker. At the beginning (P1), the player has only a little knowledge about snooker and can only perform basic shots. However, the player enjoys the activity (is in flow) because he feels that the difficulty is just right for his rudimentary skills. While training his basic shots, the player's skills are bound to improve, and he will feel bored (P2) performing such shots. - Or he might notice that playing against an opponent is still too hard and he will realize that there are much greater challenges than performing basic shots individually. His poor performance will cause feelings of anxiety (P3).



8. Extended three channel model of flow (modified from Csikszentmihalyi, 1991).

Boredom and anxiety are negative experiences that motivate the player to strive for the flow state. If the player is bored (P2), he has to increase the challenge he is facing. The player can set a more difficult goal that matches his skills. For example, he could play against an appropriate opponent that he can barely win against in order to get back to the flow state (P4). In contrast, if the player feels anxiety (P3), he must increase his skills in order to get back to the flow state (P4). The player could, for example, develop his playing strategy and train to perform safety shots. In general, it can be said that flow emerges in the space between anxiety and boredom. The three channel model of flow describes the dynamic nature of flow, but it does not provide clear tools for educators to guide students to appropriate activities contributing to the flow state. However, as

proposed in Article 1, the flow channel can be extended by providing some guidance to the person, or by providing the possibility of solving problems collaboratively. Thus, the zone of proximal development (Vygotsky, 1962) is added to the original model. For example, in the snooker case, the player could ask for help from more proficient players to help him to develop his cue technique and playing strategy.

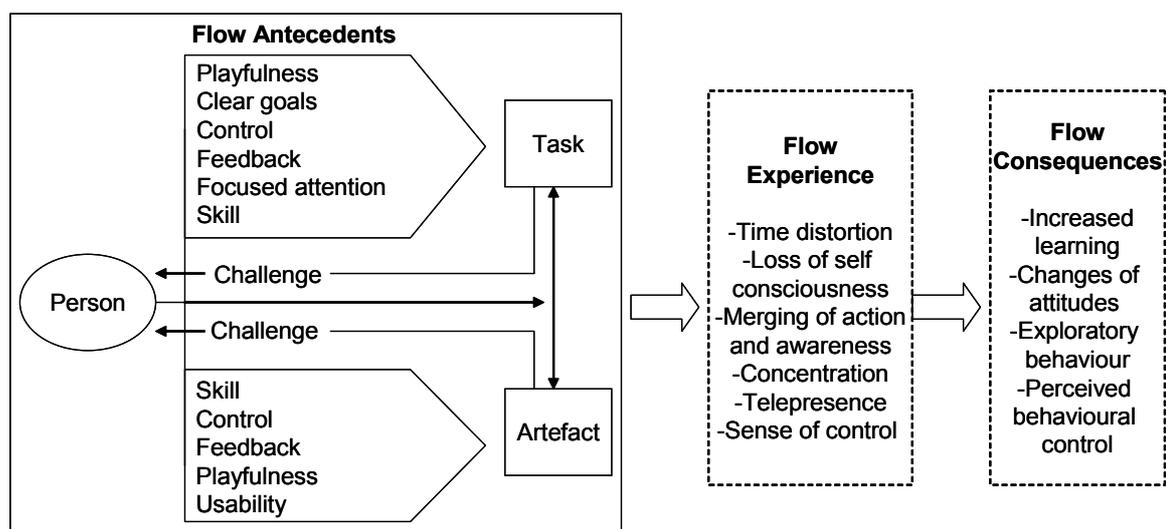
The diagram shows that flow is a linear channel where both P1 and P4 represent situations where the player is in the flow state. Although both situations are equally enjoyable, P4 is more complex because the challenges involved and skills required are greater. Neither situations P1 or P4 are stable states, because now and then the player tends to either feel boredom or anxiety which motivates him to strive for the flow state in order to feel enjoyment again. In conclusion, this dynamic feature explains why flow activities lead to growth and discovery. From the point of view of learning activities, the three channel model of flow has an important role in that it represents how the process of flow might develop through a single activity (Pearce, Ainley & Howard, 2005). In Article 5 this model is considered in the context of adaptive learning materials. Although the three channel model of flow has been refined to include four and eight different states or channels, (Pearce et al., 2005; Chen, Wigand & Nilan, 1999), they are not contradictory.

## **4.2 Flow in Computer-Mediated Environments**

In recent years Csikszentmihalyi's (1975, 1991) flow theory has been used in human-computer interaction studies as a framework for modelling enjoyment, engagement, absorption and satisfaction. The original flow activities, such as rock climbing and dancing, diverge from activities performed with computers. Finneran and Zhang (2003) argued that activity performed in computer-mediated environments needs to be broken down into the main task and the artifact used to accomplish the activity. It is apparent that the mastering of complex artifacts cannot be taken for granted. Furthermore, Finneran and Zhang (2003) proposed a person-artifact-task (PAT) model that conceptualizes the major components of a person working on a computer-related activity. According to the model, the likelihood of experiencing flow is dependent on the interplay between the same elements that constitute the user experience: a person, a task and an artifact. The main contribution of the PAT model to the flow theory is to provide a means to consider what really influences experiencing flow: the task itself, the use of artifacts or individual differences.

Finneran & Chang (2003) observed that the flow dimensions that Csikszentmihalyi presented can be categorised into three stages: flow antecedents, flow experience and flow consequences. Several researchers have used the same categorization in the context of computer-mediated environments (Skadberg & Kimmel, 2004; Chen et al., 1999; Ghani & Deshpande, 1994), but there has been some debate as to which factors referring to flow

belong in each stage. In Figure 9 a framework of flow in computer-mediated environments is presented. The framework is comprised of the factors of each stage of flow and the components of the PAT model (Hoffman & Novak, 1996; Chen et al., 1999; Finneran and Zhang, 2003; Webster et al., 1993; Skadberg & Kimmel; Ghani, 1991; Csikszentmihalyi, 1991). The framework is consistent with Aderud's (2004) view describing the same relationship between person, artefact and task in flow context.



## 9. Framework of flow in computer-mediated environments (Article 1)

All three components, person, task and artifact, should be taken into account when designing educational games. Generally, the aim of an educational game is to provide students with challenges related to the main task so that flow experience is possible. When both the task and the use of the artifact are complex, then the artifact and the task may detract from the user's attention (Pearce & Howard, 2004). Bad usability decreases the likelihood of experiencing task-based flow because the player has to sacrifice attention and other cognitive resources to the inappropriate activity. Because the information processing capacity of working memory is limited (Miller, 1956), all possible resources should be available for relevant information processing rather than for the usage of the artifacts. Thus, the aim of designers is to support the shift from cognitive interaction to fluent interaction. In an ideal situation artifacts are transparent and allow the player to focus on higher order tasks.

Because the framework of flow in computer-mediated environments integrates several researchers' interpretations of flow experience there is some overlapping. Thus, it is reasonable to distinguish the factors that the experiential gaming model presented in Section 6.3 is based upon. Flow antecedents included are: personal skills well suited to given challenges, clear goals, a sense of control, unambiguous feedback, focused attention and good usability. In this research the usability dimension includes a merging of action

and awareness dimensions as discussed in Article 6. The dimensions expressing flow experience are concentration, loss of self-consciousness, time distortion and autotelic experience. Finally, the relevant consequences of flow from the point of view of this research are increased learning, positive attitude changes and exploratory behaviour.

### **4.3 A Review of Flow Studies**

In this section the results of some recent studies on flow experience are discussed in order to constitute an overview of the utilization of flow theory. Flow theory has been utilized in different contexts ranging from quality of life (Csikszentmihalyi, 1991; Csikszentmihalyi & LeFevre, 1989), online consumer experience (Smith & Sivakumar, 2004; Novak, Hofman & Duhachek, 2003), use of information technology (Pilke, 2004; Chen et al., 1999; Skadberg & Kimmel, 2004), online learning (Pearce, et al., 2005; Kondratt, Filip & Hoffman, 2003), sports (Jackson, 1992; Jackson & Csikszentmihalyi, 1999; Marr, 2001) to game related studies (Lee & Kwon, 2005; Hsu & Lu, 2004; Järvinen et al., 2002).

#### **4.3.1 Studies on Online Consumer Experience**

Hoffman and Novak (1996) were among the pioneers in applying flow construct to the experiences of Web users. They proposed a conceptual model of flow in commercial Web environments. The model attempted to explain the relationship between flow and behavior of online consumers. Later, Novak et al. (2000) conducted survey research in order to test and validate a structural equation model that they developed on the basis of Hoffman's and Novak's (1996) earlier work. As a result, Novak et al. argued that their model of customer experience in computer-mediated environments addresses the elements that managers must consider in their online marketing programs. Furthermore, the results indicated that Web site design should provide enough of a challenge to arouse a consumer, but not too much so that he becomes frustrated with an activity.

Novak et al. (2000) also found that compelling online customer experiences correlated positively with fun, recreational and experiential uses of the Web, but correlated negatively with work-oriented activities. In order to study this phenomena more exhaustively Novak et al. (2003) conducted a study examining whether flow occurs during both experiential and goal-directed activities (n = 588). According to Hoffman and Novak (1996), drawing a distinction between these activities is important in online environments, because the experiential process tends to be as, or even more important for customers than the final instrumental result of the activity. Jackson's and Csikszentmihalyi's (1999) findings in sport activities support this way of thinking. However, the results of Novak et al. (2003) were contradictory with Novak et al.'s (2000) findings. The participants that used the Web for goal-directed purposes were more likely

to experience flow. However, the participants who used Web for experiential use also experienced flow, but more rarely.

### **4.3.2 Studies on Information Technology Use**

Chen et al. (1999) studied flow experience in the context of the WWW in order to examine the possibilities of utilizing flow theory in Web design. Researchers employed an open-ended survey instrument that allowed a wide sample of Web users (N = 304) to describe their flow experiences in their own terms. Results revealed that 39.8% of the participants had experienced flow in Web-related activities. Furthermore, they found out that information retrieval was the most commonly reported flow-inducing activity (60.6%), followed by action in newsgroups (9.2%), e-mail activities (8.3%), creating Web pages (5.5%), playing online games (4.6%), and chatting (3.7%). The flow was characterized as increased concentration (37.5%), loss of self-consciousness (20.8%), enjoyment (16.7%), and time distortion (10.4%) that is consistent with Csikszentmihalyi's (1975) findings. The study stressed that designers of Web-based systems should focus on what users are trying to do, rather than on how the technology works. This user-centered approach would lead to more usable Web-based systems. In fact, Norman (1998) proposed a model describing seven stages of action that can be utilized in this ambition.

Pilke (2004) conducted a study to investigate, whether flow experience, as defined by Csikszentmihalyi, would occur in information technology use (n = 20). Results indicated that flow experience is quite frequent in computer-related activities. Compared to Chen et al.'s (1999) study, flow was experienced more frequently. However, the most important finding of Pilke's was the fact that designing interfaces that induce flow experiences is to design good usability and visa versa. As discussed in section 4.2, usability should be still considered as only one antecedent of flow among others.

Skadberg and Kimmel (2004) proposed a flow model in the context of human-computer interaction on the Web that also includes factors contributing to good usability. Testing of the model revealed that while browsing a Web site, flow experience was characterized by time distortion, enjoyment, and telepresence (n = 272). The most important findings, from the point of view of this thesis, were that flow experience tends to lead to learning, positive attitudes and positive actions consistent with earlier results (Webster et al., 1993; Ghani, 1991). In fact, these findings lead to the premise of considering flow as a design framework for educational and user experiences.

### **4.3.3 Studies of Online Learning**

Pearce et al., (2005) used flow antecedents, skill and challenge as the primary data for measuring flow during a Web-based learning task. Two versions of educational software were used: a movie simulation and an interactive simulation. The learning task consisted

of seven sub-tasks dealing with basic physics. After an each sub-task, a challenge-skill questionnaire was provided to students asking them to rate, on a 5-point Likert scale, how challenging they found their last activity and how they perceived their own skills to meet these challenges. This method allowed researchers to study flow as a process rather than just an overall state. The data from the challenge-skill questionnaires were used to plot each individual's flow-path through a sequence of sub-tasks reflecting the changes on flow experience.

Results indicated that the version of the software did not affect flow experience. As the main result Pearce et al. (2005) argued that flow-path representation is a valuable tool in an analysis of the flow process. In general, it gives new insight about learners' behavior in online learning environments. However, Chen et al. (1999) argued that researchers studying flow phenomena in the Web environment too often operationalize the perceived challenge too generally. Researchers tend to ignore the original conception of flow as a construct that induces human beings to grow in the sense of fulfilling their potentialities and going beyond those limits. The process measuring method that Pearce et al. (2005) used caters to the dynamic nature of flow. However, the question is, how valid are the evaluations of students of the perceived challenge? In fact, in their study Chen et al. (1999) found out that a great number of the participants were confused about questions measuring challenge. The skill-challenge approach can be utilized in flow studies, but it is not an adequate measuring method alone, because flow is such a complex construct.

In conclusion, the review of literature revealed that flow theory has not been utilized in the design of digital learning materials. For that reason studies on flow as a design framework are needed.

#### **4.3.4 Studies on Sports**

Flow experience is also applied to sports. An important work in this area is the book, "Flow in Sports: The Keys to Optimal Experiences and Performances", by Jackson and Csikszentmihalyi (1999). According to the authors of the book, sports can offer such rewarding states that one does it for no other reason than to be part of it. Furthermore, they argue that a sport setting is structured to enhance flow. Although, winning in sports is important, flow does not depend on final outcomes of an activity, and offers athletes something more than just a successful outcome.

Following is a description of flow offered by a runner (Jackson & Csikszentmihalyi, 1999, 4):

*"I felt really in control, just felt terrific the whole way, and didn't feel that pain that I would normally feel in that run...[i] just really enjoyed the experience of running and really had probably the most successful race ever of my life...It*

*wasn't as painful as the others. I felt very in control, I felt very strong. I was able to run as I had planned...I felt really focused. I just felt like, you know, like athletes say, "It clicked"; it felt great the whole way."*

In reality, the pain that the runner usually experienced while running was also there in this run, but the runner was so focused on his activity that he did not notice it. In fact, an optimal experience usually occurs when a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile (Csikszentmihalyi, 1991). Such experiences are not necessarily pleasant when they occur, but they still produce enjoyment. This view is thought-worthy when considering flow in educational games. Experience leading to states of enjoyment does not require the gaming to be easy and effortless in order to support flow. On the contrary, educational games should stretch the minds of players to their limits in an effort to overcome worthwhile challenges.

#### **4.3.5 Studies on Games**

Game designers can be regarded as professionals in designing flow-inducing activities. However, literature is short of documented studies on flow experience in a game context. This can be the result of the fact that game designers do not refer directly to the flow experience proposed by Csikszentmihalyi, but they certainly consider similar factors contributing to the flow experience. For example, Lehtimäki (2005) referred to zone experience when describing games holding power. In fact, the concept *being in the zone* is commonly used in flow-related sports studies (Lewis, 1999; Krug, 1999). On the other hand, game designers Rollings and Adams (2003) referred to a Zen-like state when discussing the phenomenon called *Tetris trance*. During this state, players of Tetris seem to lose track of time and concentrate on the entire playing area as a whole. To conclude, the statement of Costikyan (2002), arguing that "I have no words & I must design", describes the state of art of academic game studies revealing the lack of consistent design and research vocabulary.

Lee and Kwon (2005) studied the effect of flow connected to success in a computer-based simulation game. In the experiment 100 university students played the simulation, Roller Coaster Tycoon, for a total of 30 minutes. The game scores were collected as achievement data. After the playing session the level of flow was measured using a questionnaire consisting of four categories: intrinsic interest, attention focus, curiosity, and control. Results indicated that flow was not the significant predictor in game achievement. This study can be criticized for the short time that players were allowed to play the game. Thirty minutes for a playing session seems to be too short for studying the relationship of flow and game achievement in complex simulation games. In as short a time as 30 minutes the use of game achievement scores can be also questioned, because they do not reflect things that the player has learned during the game. For that reason it would have been reasonable to have two game sessions: a session for the player to become

familiarized with a game and a session for collecting the scores. Such practice would have worked better in this endeavor. In addition, the players' skill levels should have been somehow measured before the playing session in order to be able to take them into account in analysis.

Hsu and Lu (2004) applied a technology acceptance model (TAM) that incorporates social influences and flow experience as a construct to predict peoples' acceptance of online games. Hsu and Lu proposed an extended TAM model, which was evaluated on the basis of survey data about participants' acceptance of online games. The results indicated that social norms, attitude, and flow experience explained 80% of the game playing. The problem with the study was the extended TAM model that Hsu and Lu constructed. In their model, usefulness plays an important role, which is not reasonable in an entertainment game context. Usefulness did not motivate users to play online games, as the results indicated. However, flow experience was one of the major predictors of intention to play online games. In addition, usability of game interface played a critical role in forming flow experience. In the game context we could talk about playability, as Järvinen et al. (2002) proposed. According to their terms, playability is a notion that incorporates the relevant aspect of both flow and usability.

Järvinen et al. (2002) used Csikszentmihalyi's (1991) conception of flow in work that introduced a theoretical tool for studying digital entertainment and games. The central purpose of their study was concerned with the relationship of gameplay and playability concepts and form a game flow framework. A formed game flow framework including Csikszentmihalyi's nine flow dimensions tailored to game context can be used to understand what constitutes a satisfying gameplay experience. The game flow framework is quite general and sticks tightly to Csikszentmihalyi's (1991) conception of flow. However, the framework was applied in practice in the form of evaluating playability. The term playability and relevant aspects of game flow framework are presented in the next section dealing with games and learning.

Recently, Sweetser and Wyeth (2005) also constructed a GameFlow-model for evaluating enjoyment in games. The GameFlow-model consists of concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction elements, each including a set of criteria for achieving enjoyment in games. The model was tested by conducting expert reviews of two real-time strategy games. The results indicated that the GameFlow-model is a useful tool for evaluating high-rated and low-rated games as well as identify the success factors of games. The GameFlow criteria proposed by Sweetser and Wyeth are quite extensive and also provide elements that can be applied to educational game design. In conclusion, the GameFlow-model provides much clearer tools for analyzing flow experience in games than the game flow framework proposed by Järvinen et al. (2002).

## 5 Games and Learning

Generally, games satisfy the basic requirements of learning environments identified by Norman (1993) and can provide an engaging environment for learning. Traditionally, games are equated with having fun. However, the fun factor is not a key for successful educational game design. The promise of educational games is to engage and motivate players through direct experiences via the challenges included in the game world. Educational games should provide possibilities for reflectively exploring phenomena, testing hypotheses, solving problems and constructing knowledge. In this section the core elements of games are presented and the utilization of games in education is discussed.

### 5.1 Games Defined

Johan Huizinga's book *Homo Ludens* (1944/1980, 13) was the first major contribution to the study of games. In his book Huizinga defined play as follows:

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

Huizinga's definition of play, as well as his term 'magic circle', has been used in the emerging field of game studies until the present. Originally, Huizinga used the term 'magic circle' as an example of an isolated play-area obtained by certain rules. As we can see 'magic circle' reflects Huizinga's definition of play by emphasizing the phrases "standing quite consciously outside ordinary life" and "within boundaries of time and space". Later on, for example, Salen and Zimmerman (2004) adapted the magic circle concept. According to them, to play a game means entering into a magic circle (accounting for second-order reality) or creating one as the game begins. Rollings and Adams (2003) refer to magic circle with the term *suspension of disbelief* reflecting a mental state in which a player chooses, for a certain period of time, to believe that this pack of lies (the game) is reality. Further, magic circle is also interpreted as the "holding power" of games (Järvinen, 2004). In that sense it would have clear connections to flow theory, but the original meaning of magic circle does not justify using it with that meaning. If anything, magic circle reflects a state of immersion, defined as a sensation of being surrounded by a completely other reality taking over all of our attention (Ermi &

Mäyrä, 2005b). However, it does not consider the engaging and rewarding nature of an activity that is typical of flow experience.

Although, Huizinga's definition of play is quite good, it has been criticized at the same time as being too broad and too narrow (Caillois, 1958/2001). As a response, Caillois defined play as an activity which is essentially: 1) Free: voluntary activity; 2) Separate: circumscribed within limits of space and time, defined and fixed in advance; 3) Uncertain: the course of the play can not be determined, nor the result attained beforehand; 4) Unproductive: creating neither goods, nor wealth, nor new elements of any kind except for the exchange of property among the players; 5) Governed by rules; 6) Make-believe: accompanied by a special awareness of a second reality. Caillois' definition does not differ substantially from Huizinga's definition, but it is more like a corrective extension of it. Both definitions are appropriate for educational games also except for the fact that educational games can be productive. For example, in IT-Emperor, players are employed to produce content components during the game.

Furthermore, Caillois (1958/2001) divided games into four classes: competition, chance, simulation, and vertigo. Competition refers to games like billiards, chess or soccer; chance to roulette or lottery; simulation to Nero or Hamlet; and vertigo to games producing a rapid whirling or falling movement, a state of dizziness and disorder. It is noteworthy, that the games of chance do not contribute to flow experience, because in such games the player is unable to achieve control over the playing activities. Of course the game can include some elements of chance, but the main success factor in flow inducing educational games should be based on the skills of the player. In order to classify and compare diverse games under the same category Caillois formed a continuum describing the complexity of a game's rules. At the other end there is ludus that can be understood as serious, rule-bound and goal-oriented play, whereas paidia is located at the other end and is the realm of child's play with less strict rules. Later Frasca (1999) interpreted the paidia-ludus continuum in the following way. He argued that ludus refers to games containing a rule that specifies a winning condition while paidia refers to play-activities with rules but without winning conditions.

In the terms of Caillois (1958/2001) the IT-Emperor game constructed in this thesis can be considered as being a fusion of competition and simulation because it consists of competitive elements and role playing aspects. Furthermore, although IT-Emperor does not include a clear winning state, it can be regarded as a ludus based game.

The work of both Huizinga and Caillois is significant for game studies. In fact, most theories concerning games seem to be based on the ideology of these game research pioneers. For, example, the following two-fold definition of a game which is adopted in this thesis has clear common interests with Caillois' play theory. According to Järvinen et

al. (2002) a game is 1) a sequence of actions with formal and predefined rules and goals. The rules define the actions that a player can and cannot make. Combinations of rules form structures that can be used to define certain gameplay experiences. In order to guarantee fair playing experiences to players, the rules have to be consistent. 2) In most games the rules include a definition of the victory condition, or at least gain and loss (Järvinen et al., 2002). Depending on the rules, a game can be competitive or cooperative (Rollings & Adams, 2003). In competitive games players strive for the victory condition while preventing other players from doing so. In contrast, in cooperative games players strive for the victory condition as a group. Generally, the gains and losses reflect the outcome and progress of the game. IT-Emperor can not be classified as either a competitive or a cooperative game. It is more like a hybrid of these categories. In some sense, the players' behaviour and their playing strategies determine the nature of the game.

Further, Järvinen et al. (2002) divided game into three macro-level states: before, during, and after. *Before* refers to the initial state of the game where each player has equal resources available. For example, a snooker game starts with the score 0-0. However, the rules of the game can define an initial state where some of the players can have advantage. For example, in golf less proficient players get an advantage in order to equalize the differences between the players' skills. Such a practice contributes to the flow theory because the predefined handicap system equalizes skill levels between players. From the flow theory point of view, this equalization facilitates the playing experiences of both less proficient players and proficient players. *During* refers to the actual playing session where gameplay events take place. In this state, players interact with the game world and try to achieve gains. Gameplay is defined below in more detail. *After* refers to the state where gains and losses are translated to winning and losing or to other metrics. In some games there is not a clear victory condition (Rollings & Adams, 2003). For example, in Sim City a player can set his own goals for what he is trying to achieve. Thus, Sim City can be described as *paidea* in terms of Frasca (1999).

### **5.1.1 Gameplay**

Gameplay is the core of the game and its significance should not be underestimated. According to Costikyan (2002), good gameplay keeps a player motivated and engaged throughout an entire game. Although there have been attempts to define gameplay, no universally accepted definition exists. Game designers Rollings and Adams (2003) have defined gameplay as one or more causally linked series of challenges in a simulated environment. In fact, gameplay also includes the actions that players can take to meet challenges. Thus, the implementation of a game's input/output system that enables interaction with the game is related to gameplay (Rouse, 2004). Further, Rollings and Adams (2003) have argued that gameplay is independent of the audiovisual implementation.

Unlike Rollings and Adams (2003), Ermi and Mäyrä (2005b) consider gameplay in the context of players' experiences. They define the gameplay experience as an ensemble made up of the player's sensations, thoughts, feelings, actions and meaning-making emerging during a unique interaction process between the player and the game. Based on observations of game-playing children and their non-player parents Ermi and Mäyrä (2005b) constructed a gameplay experience model. The model includes some of the key components of the gameplay experience focusing on immersion. Because immersion as a phenomenon resembles flow experience which is the core of this thesis, the following description of the gameplay experience model is restricted to immersion.

Immersion can be defined as a sensation of being surrounded by a completely other reality taking over all of our attention (Ermi & Mäyrä, 2005b). In the model immersion is divided into three components: sensory, challenge-based and imaginative immersion. Sensory immersion is related to the audiovisual execution of games. Amazing graphics and powerful sounds easily overpower sensory information coming from the real world, shifting a player's attention entirely on the game world and its stimuli. On the other hand, challenge-based immersion concentrates on interaction between the game and the player. It corresponds to Csikszentmihalyi's (1991) challenge-skill dimension while it assumes that the feeling of immersion is most powerful when the player can achieve a balance between challenges and abilities. The last component, imaginative immersion, enables the player to become absorbed with the stories and the game world, or to identify himself with game characters. Generally, imaginative immersion reflects the possibility of using imagination and enjoying the fantasy of the game.

Although, immersion externally is quite a similar state to flow, it differs from flow in how it captivates a player. In flow a player directs all attention to a certain goal directed activity, whereas immersion means becoming physically or virtually a part of the experience itself. In short, the voluntary direction of attention to relevant content, which is an essential prerequisite for learning, makes the flow theory more interesting from an educational designer's point of view than the gameplay experience model. Furthermore, the flow antecedents provide a clearer and more suitable framework upon which to base the experiential gaming model than the gameplay experience model. However, this does not mean that immersion is considered as an unwanted state, but more like a lower level expression of flow experience, including several important aspects to be considered during game design.

Endeavors to design engaging educational games have probably often failed because the educational aspects have displaced gameplay. Underestimation of gameplay can also be seen in the entertainment games market. Often the technology-driven games that have neglected gameplay, while concentrating on technological achievements, disappear from

the market quite quickly. For that reason, both dimensions, educational goals and gameplay, should be balanced in order to achieve a meaningful entity in educational game design.

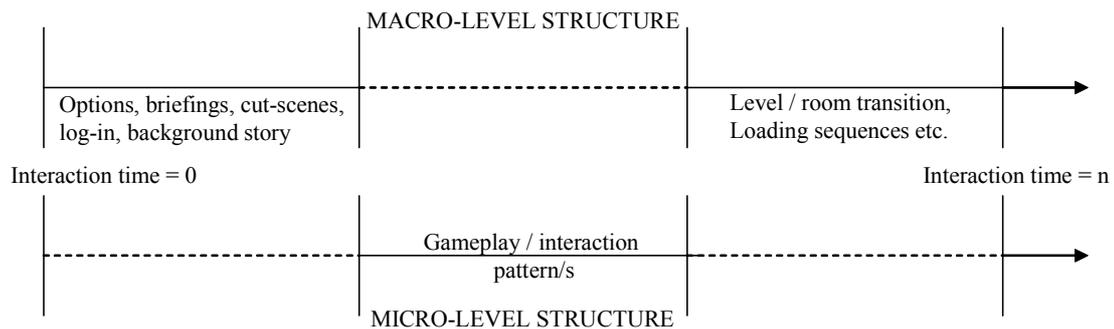
### **5.1.2 Playability**

Playability is linked to the interaction between the player and the game. According to Järvinen et al. (2002), playability refers to guidelines regarding how to implement the desired sort of gameplay. Järvinen et al. formed an evaluation tool of playability that is based on the game flow framework. This tool is divided into 1) functional, 2) structural, 3) audiovisual, and 4) social components. The most relevant aspects of these components for this thesis are discussed next.

Functional playability concerns the functional variables that affect gameplay. Functional playability is related to usability and it is one of the preconditions of the flow experience with games. In the terms of Rouse (2004), this component deals with the input/output element of gameplay. It considers how well the control peripherals are suited to successful gameplay. Educational games, in particular, should be easy to control in order to release cognitive resources for higher order tasks. At the least, the flow antecedents, immediate feedback and potential control, contribute to functional playability.

According to Järvinen et al. (2002) there are two variables that give structure to games: rules and patterns. Interaction between the player and the rules comprise gameplay patterns. As Csikszentmihalyi (1991) stated, *“The rules of games are intended to direct psychic energy in patterns that are enjoyable, but whether they do so or not is ultimately up to us.”* Although the rules of an educational game could provide patterns so that flow experience is possible, in the end, the attitudes of players determine if flow is going to occur. For example, if a professional snooker player has problems with his manager and concerns about other things than the game itself, flow is not likely to occur.

Patterns develop into either micro-level or macro-level structures (Järvinen et al., 2002). Micro-level structures refer to actual gameplay events which require a player to focus psychic energy into playing the game. On the other hand, macro-level structures refer to mission briefings and activities like that. Figure 10 illustrates the relationship between these structures governed by rules.



10. Generic structural model of user experience in digital entertainment (Järvinen et al., 2002)

Järvinen et al. (2002) argue that flow theory is not completely adequate for explaining why people enjoy games even when they might face the fate of losing, as well as recurring moments of frustration while playing a game. They also state that in games micro-level elements of both enjoyment and frustration, and even dull tasks are found satisfying if the game holds a promise of progress and reward in the larger scheme (macro-level structure). However, similar structures can also be seen in the work of Jackson and Csikszentmihalyi (1999) on sports. For example, a training program of swimmer training for an important competition may consist of briefings with the coach and recurring training sessions. In activities like swimming, the recurring training may feel frustrating but the possibility of experiencing flow in competition situation motivates the swimmer to keep on training. Therefore, flow theory does not claim that the activity should be enjoyable all the time. Generally flow can be seen as being a state occurring once in a while under certain circumstances. Finally, Jackson and Csikszentmihalyi (1999) argued that *“Once attained, flow experiences remain etched in the memory and provide the blueprint for returning to this optimal state.”*

Juul (2002) divided games into two extremes, games of emergence and games of progression. Emergence refers to game structures where a game is specified by a small number of rules that combine and yield a large number of variations, which players then design strategies to deal with. On the other hand, progression constitutes games where a player has to accomplish a predefined set of challenges in order to complete the game. Games of emergence and progression constitute different playing experiences for players. In games of progression interaction possibilities tend to be less open and repetitive structures do not necessarily produce desired experiences for players (Järvinen et al., 2002). Many educational games, including IT-Emperor, fall into games of progression. The downside of progression games is that they are not re-playable without some modifications to the challenges provided. In addition, in games of progression the game designer has a strong control over game events, which may negatively affect a player’s experiences because the player may feel that he does not achieve a sense of control over

the game. As mentioned before, a sense of control is considered one of the most important flow antecedents in games (Ghani & Deshpande, 1994).

Audiovisual style and appearance of the game influence the experience of players and should be targeted for a certain audience segment (Järvinen et al., 2002). Generally, audiovisual playability is tied in to functional and structural components that should support one another. For example, dimensionality and the point of perception of the game affect implementation of the functional playability. In an educational setting, what kind of audiovisual implementation is appropriate should be clearly considered. Fancy 3D graphics may immerse players, but are such implementations worthwhile when compared to the huge resources required? For example, Elliot, Adams, and Bruckman (2002) argued that 3D video games are not a magic bullet in education. In their study the expectations of students for AquaMOOSE (3D math software) were high due to the production values seen in commercial video games. Additionally, the 3D implementation of the AquaMOOSE software introduced usability concerns and increased content complexity.

The social playability component is used to consider what kinds of social practices the game is suitable for (Järvinen et al., 2002). In order to maintain a community of players, a game should provide functionalities that encourage community formation. In other words, players should be able to share knowledge and opinions in the game world. In addition, a persistent game world supports the creation of social networks. Two communicative functionalities can be distinguished in games: off-game functionalities and on-game functionalities. Off-game functionalities refer to communication that is secondary to gameplay, i.e. communication outside the game session. Meanwhile on-game functionalities refer to communication related to gameplay events taking place during the gameplay session. Current learning theories stress the meaning of social knowledge construction and thus the social aspect in games should be considered. However, the role of social playability should be conditioned to contexts of use and cultural aspects.

## **5.2 Players as Problem Solvers and Explorers**

Generally, games provide a meaningful environment for problem-based learning. The ability to solve problems is one of the most important features of human skills (Holyoak, 1991). Therefore, one goal of education is to groom students to encounter novel situations (Bruer, 1993). Problem-solving can be regarded as striving toward a goal which is not immediately attainable. Games provide a meaningful framework for offering problems to students. In fact, a game itself is a big problem that is composed of smaller causally linked problems. The nature of challenges that constitute the problem can vary a lot. In general, it can be anything that somehow restricts a player's progress in the game world. The following quote reveals that some educators have noticed the powerfulness of games in their work.

*“Although I can not define a mathematical game any better than I can a poem, I do maintain that, whatever it is, it is the best way to capture the interest of young people in teaching elementary mathematics. A good mathematical puzzle, paradox, or magic trick can stimulate a child’s imagination much faster than a practical application (especially if the application is remote from the child’s experience), and if the “game” is chosen carefully it can lead almost effortlessly to significant mathematical ideas.”*

(Gardner, 1990, xi)

Although, Gardner regards puzzles and magic tricks as superior to practical applications in clarifying ideas that is not the case in higher education. Students demand authentic and practical exemplars in order to ground the issues to be learnt. In fact, games are useful tools in this endeavor since they can be designed to allow players to experience learning tasks in authentic environments.

The problems used in games can be classified into well-structured or ill-structured problems (Hong, 1998). Well-structured problems have definitive answers. In contrast, ill-structured problems, normally encountered in real life, have unclear goals and incomplete information related to the problems. The best solutions to ill-structured problems depend on the priorities underlying the situation. Papert (1993) stressed that ill-structured problems are more meaningful for the problem solver than well-structured problems because they offer more opportunities for a problem solver to use different problem-solving strategies. Educators and researchers have tried to develop learning environments that support problem-solving in complex life-like situations (Bilgin & Karakirik, 2005; Houstis et al., 1998; Lohani, Kibler & Chanat, 2002). In fact, games provide a means of offering possibilities for students to set personal goals, actively handle, and gather information as well as monitor and evaluate problem-solving processes. However, the development of games consisting of ill-structured problems is harder than games based on well-structured problems. Supplying direct and immediate feedback for players, in particular, is difficult in ill-structured problems which was also the case in IT-Emperor.

Problem-solving can be associated with discovery learning (Bruner, 1961). Learning environments, such as games, allow students to discover new rules and ideas rather than memorizing material that others have presented. For example, simulation games offer possibilities for students to interact with the game by exploring and manipulating objects in order to test their hypotheses. Thus, while experiencing the game world, students become active participants in the learning processes and their motivation may shift from extrinsic to intrinsic rewards (Bruner, 1961). At this point learning theories that can be seen as the most relevant from an educational game design perspective should be considered.

## 5.3 Relevant Learning Theories for Educational Gaming

Different views of learning are closely related. For example, experiential learning and constructivism have a lot in common, which may be a consequence of the fact that both theories are based on thoughts by the very same authors (Dewey, Piaget, Lewin). In this section, the emphasis is on both experiential learning and constructivism that are briefly discussed in order to form a conceptual basis of learning for the experiential gaming model presented in the next section.

### 5.3.1 Constructivism

Constructivism is not an integrated theory, but it consists of a broad diversity of views. The main debate between constructivists is the relevance of social and cultural settings in learning. In fact, constructivism is divided into individual constructivism and social constructivism (Smith, 1999). Currently, it seems that attention is shifting from the Piagetian view, stressing constructive activity as an individual process isolated from cultural aspects and social settings, to the Vygotskian view that emphasizes the meaning of the situated nature of learning within social and cultural settings. Generally, both individual and social constructivists understand learning quite same way, assuming it as an active knowledge constructing process (Resnick, 1989). However, they consider learning phenomenon from a different perspective just like an ecologist and a biologist consider phenomena differently. Smith (1999, 413) has successfully described the debate between constructivists with following metaphor:

*“Individual constructivist can’t see the forest for the trees”  
“Social constructivist can’t see the trees for the forest.”*

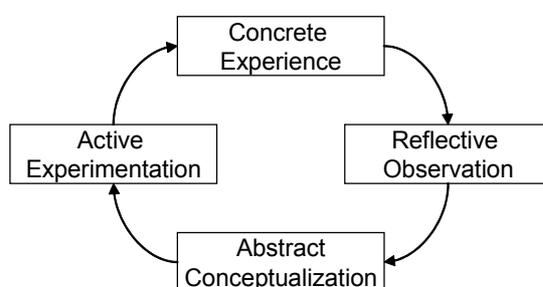
Both views are well-grounded and there should not be any debate as to which perspective is the best and sole view on learning. Generally, both views have a lot to offer to designers of educational software and the emphasis should be proportioned to the context of use.

Generally, the main points of different constructivist views can be encapsulated as follows. Firstly, learning is considered as an active knowledge-constructing process where people actively construct their own knowledge through interaction with the environment and through reorganization of their mental structures (Resnick, 1989; Phillips, 1995; Tytler, 2002). Secondly, instruction is considered only as a tool that supports the knowledge construction process (Duffy & Cunningham, 1996; Jonassen, 2000; Jonassen et al., 1999). Similarly the aim of digital learning environments and tools is to support learner’s knowledge construction process either individually or socially. According to Jonassen et al. (1999) technologies can support the construing of meaning by students, but this can happen only if students learn with technology, not from it.

Constructivist learning environments are technology-based environments in which students experiment, explore, construct and reflect on what they are doing (Jonassen et al., 1999). Furthermore, in such environments students learn from their experiences. Honebain (1996) has distinguished seven pedagogical goals that should be considered when designing constructivist learning environments: 1) Provide experience with the knowledge construction process. 2) Provide experience in and appreciation for multiple perspectives. 3) Embed learning in realistic and relevant contexts. 4) Encourage ownership and voice in the learning process. 5) Embed learning in social experience. 6) Encourage the use of multiple modes of representation. 7) Encourage self-awareness of the knowledge construction process. These goals provide a solid framework for designers of constructivist learning environments to put theory into practice.

### 5.3.2 Experiential Learning

Experiential learning builds upon the work of Piaget, Lewin, and Dewey (Kolb, 1984). For example, Dewey (1938/1997) stated that all genuine education comes from experience. Although Dewey can be considered as being one of the pioneers and major contributors to experiential learning, he did not address how the scientific method in learning was to be operationalized (Lainema, 2003). Kolb addressed this problem until the early 70's (Ekpenyong, 1999). Since then several models stressing the importance of direct experience and reflective observation have been proposed. Kolb's (1984) view of experiential learning, referring to the Lewinian experiential learning model (Figure 11) that consists of four stages, is the central work in this field. According to Kolb, learning begins with a concrete experience, followed by collection of data and reflective observations about that experience. Experiences can be obtained through real life or in a virtual environment. In the abstract conceptualization stage a learner makes generalizations, draws conclusions, and forms hypotheses about the experience leading to new knowledge. In the final stage, the learner tests these hypotheses and ideas through active experimentation in new circumstances. The model stresses the continuous nature of learning, as well as appropriate and immediate feedback which provides the basis for a continuous process of goal-directed action (Kelly, 1997).



11. The Lewinian experiential learning model (Modified from Kolb, 1984, 21)

Kolb (1984) combines different views on experiential learning and provides some guidelines for experiential learning as follows.

- Learning can be best conceived as being a continuous process grounded in experience.
- Learning is a knowledge construction process involving transactions between a person and the environment.
- Learning is a holistic process of adaptation to the world.

Kolb's (1984) view on experiential learning has some connections to constructivism. Firstly, learning is understood as being an active knowledge construction process. Secondly, the learning process involves transactions between a person and the environment. Thirdly, prior experiences direct a person's way of thinking and knowledge construction. The ideology of experiential learning, supplemented with a constructivist perspective, provides a fruitful basis for integration of gameplay and pedagogy. In fact, both experiential and constructivist views have been used as a basis for designing business games for years (Isaacs & Senge, 1992; Lainema, 2003; Nielsen-Englyst, 2003). For, example, Gredler (1996) argued that educational games and simulations are experiential exercises. Further, because games can be considered as state machines (Fu & Houlette, 2002) allowing players to creatively test hypotheses and reflect on outcomes in the game world, experiential learning theory is an appropriate framework for construction of educational game design models.

## **5.4 Studies on Educational Games**

Games for educational purposes have a long history. The first war game simulations for education were used in China in about 3000 B.C. (Lainema, 2003). Later on military officers of the Western world also honed battle strategies with war games. According to Naylor (1971) one of the first business games goes back to 1956 when the Top Management Decision Game was revealed. However, digital games for educational purposes were not introduced until the 1970's. Since then games have been used, for example, to teaching basic skills, like reading (Schwartz, 1988), language (Baltra, 1990) and calculation (Sinnemäki, 1998), to teach society skills, like self-efficacy in HIV/AIDS prevention (Thomas et al. 1997) and for social learning, such as encouraging successful dialogue skills (Ravenscroft & Matheson 2002). In addition, games have also been used to train special skills, like decision-making in business (Lainema, 2003; Töyli, 2001). Following is a short review of selected studies on educational games.

Thomas et al. (1997) studied the effectiveness of an educational game, "Life Challenge," developed by the New York State Department of Health as a tool for enhancing adolescents' sense of self-efficacy in HIV/AIDS prevention programs (N = 211). "Life Challenge" is an adventure game which provides information and non-threatening skill

practice sessions for players. In the game players "negotiate" with their chosen partners. They are allowed to play back the responses given. An evaluation of the game indicates that players took negotiating tasks seriously and statistically significant learning gains were achieved on knowledge items as well as in self-efficacy scores.

Also Brown et al. (1997) conducted a medicine-related study (N = 58) in order to evaluate the effectiveness of an interactive video game designed to improve self-care among children and adolescents with diabetes. In that game, a player takes the role of an animated character who tries to manage his diabetes by monitoring blood glucose, taking insulin injections, and choosing foods, while setting out to save a diabetes summer camp from marauding rats and mice. The findings of the study were promising and indicated that well-designed, educational video games can be effective interventions.

Halttunen and Sormunen (2000) studied educational games in a more formal setting. They constructed an Information Retrieval Game (IR Game) that is based on the idea that test collections used in laboratory-based IR experiments could be used in instruction as a rapid query analysis tool. The goal of the game is to provide a realistic environment for demonstrating the performance of queries in different types of search situations. Although Halttunen and Sormunen call this computer-supported learning environment "IR Game", it has only a few game features, such as the opportunity to see the best query formulations and achieved results of other players. This, according to the experiments, created a competition that tended to foster learning. Although the IR Game resembles an exercise tool more than a game, it has a lot of potential to offer to IR education. However, players' experiences could be facilitated by adding more game features, such as stories, in order to situate and connect the IR tasks included more realistically.

In fact, researchers of business games have noticed the importance of situating learning tasks. Generally, the usage of games in business education seems to be more common than in other areas. The roots of business gaming go back to 1956 (Naylor, 1971). Among others Töyli (2001) and Lainema (2003) have recently contributed to business gaming. For example, Lainema (2004) constructed an educational business game called Realgame. As the name of the game suggest, it is designed to give players a realistic view of business processes through case-based learning. An important characteristic of Realgame is its continuous nature which reflects realistic time-dependent decision-making in the business world. Such continuous processing presents authentic tasks rather than abstract instructions. Configurability is another important feature of Realgame because it enables providing different business environment scenarios to players in order to support a deeper understanding of business processes. The evaluation results of Realgame revealed that the game-based method motivated players. Realgame was considered to be a useful business process learning tool.

In conclusion the studies on educational games presented point out that games have a lot of potential for use in education. However, the small amount of existing studies on educational games refers to either a lack of development resources or to the construction problems of games. Otherwise there should be more research on educational gaming that has proven itself to be such an engaging, effective learning method. In fact, Moreno and Mayer (2005) argued that the field of educational technology lacks research on how to design game environments that foster knowledge construction and deepen understanding. The resources of designers could be saved by constructing educational game design models and design guidelines. The next section focuses on this dilemma.

## 6 Educational Game Design – Towards an Experiential Gaming Model

Educational technology research has a shortage of studies on educational game design. In this section, the work that exists on educational game design is briefly reviewed. However, the emphasis of this section is on a constructed experiential gaming model which aims to build a bridge between education and game design aspects.

### 6.1 Previous Work on Educational Game Design

Quinn (1994) proposed a methodology for designing educational computer games based upon what is known about how people think, learn, and design. Quinn is apparently a constructivist because he emphasises the meaning of situated action, knowledge construction, and reflective instruction. He argues that the proposed model of educational game design (Table 1) combines the elements of instructional design and system design. However, he does not present any instructional theories which would be relevant to reach the goal of the model.

Table 1. Proposed steps for instructional game design (Quinn, 1994)

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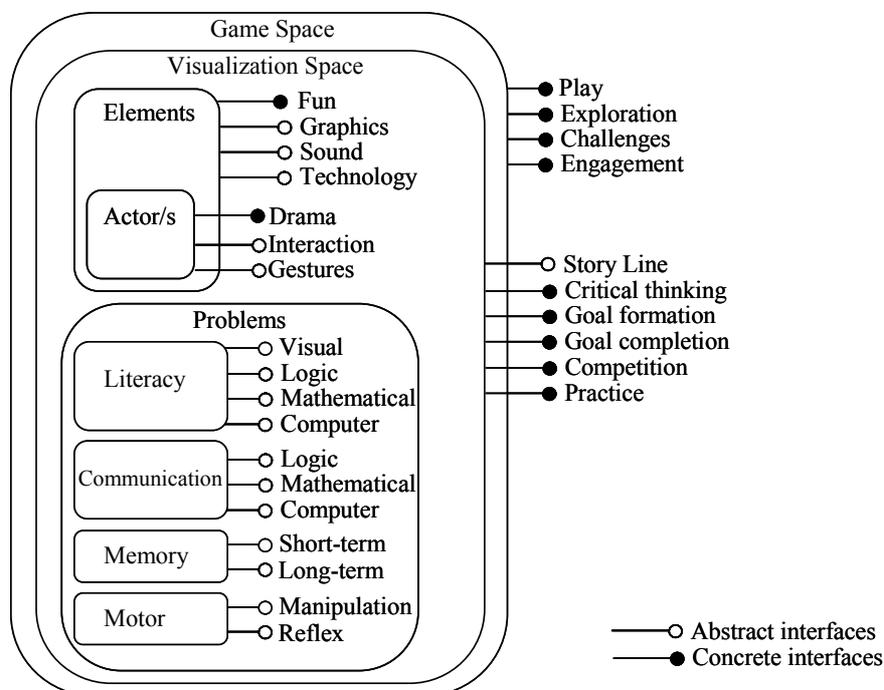
<b>Analysis</b>
Determine target performance
Determine learning characteristics
<b>Specification</b>
Determine pedagogical approach
Situate the task in the model world
Elaborate the details
Incorporate underlying pedagogical support
Map learning activities to interface actions
Map learning concepts to interface objects
<b>Implementation</b>
Prototype
<b>Evaluate</b>
Pilot test
<b>(Repeat)</b>

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The specification stage of the model utilizes the elements of fun proposed by Malone (1981). Quinn (1994) stated that the game should include elements of curiosity, chance

and fantasy leading to immersion, engagement and intrinsic motivation. Curiosity refers to the promise of an exciting event of the game which should be maintained throughout the game. Fantasy referring to story line is relevant in all games because it situates the challenges provided within a certain context. Although Quinn emphasises the meaning of the element of chance, in the author's opinion this is not necessary in educational games. However, if these chance features are well implemented and they do not distort the balance of the game, they can be utilized. Quinn's view on challenge is interesting and resembles Csikszentmihalyi's (1975) ideas. Alike the author of this thesis, Quinn argues that Vygotky's zone of proximal development should be considered when designing challenges and related systems. Finally, Quinn provides an implementation rule according to which objects that are acted on need to be concepts that are instructionally relevant. Generally, this means that the content to be learned should be included in gameplay events, not in mission briefings or other macro-level structures. Similarly Lankoski and Heliö (2002) emphasise the meaning of action as one of the most important features of games.

Later on Amory and Seagram (2003) tried to integrate educational theory and game design aspects. They proposed a set of models as a result that could be utilized in educational game design. The central model of their work is the Game Object Model (GOM) that attempts to create a dialectic between pedagogical dimensions and game elements (Figure 12).



12. Visualization of the Game Object Model (Amory & Seagram, 2003)

The GOM includes components promoting educational objectives (abstract interfaces) and components that allow the realization of such objectives (concrete interfaces). Furthermore, the interfaces are listed from the most to the least important. However, no account for this prioritizing is provided. Generally, the GOM consists of a wide range of things that can be associated with games and game design, but in the author's opinion it does not offer enough information for utilizing the GOM in practise. Similarly the connection between educational theory and game design aspects is far too lightweight. Although, Amory and Seagram (2003) presented a Persona Outlining Model (POM) providing researchers the means to match game development with its intended audience and a Game Achievement Model (GAM) which provides a way to realize the GOM, all these models, GOM in particular, are too superficial. One essential flaw of the GOM is the lack of an account for the included problems. Are these problems derived from research or are they just conceptual choices? In fact, the forefather of the GOM (Amory, Naicker, Vincent & Adams, 1999) consisted of manipulation, memory, logic, mathematics and reflexes problems that were based upon studying commercial entertainment games (SimIsle, Red Alert, Zork Nemesis and Duke Nukem 3D). However, these games are remote from educational games and in the author's opinion the existence of the problems mentioned in the GOM can be questioned.

In conclusion, the reviewed approaches of educational game design do not offer enough information on educational gaming and their function of bridging pedagogy and game design is questionable. An important question still remains as to how we can design engaging, effective educational games. Before presenting an experiential gaming model that tries to answer this question an experiential design paradigm is briefly presented.

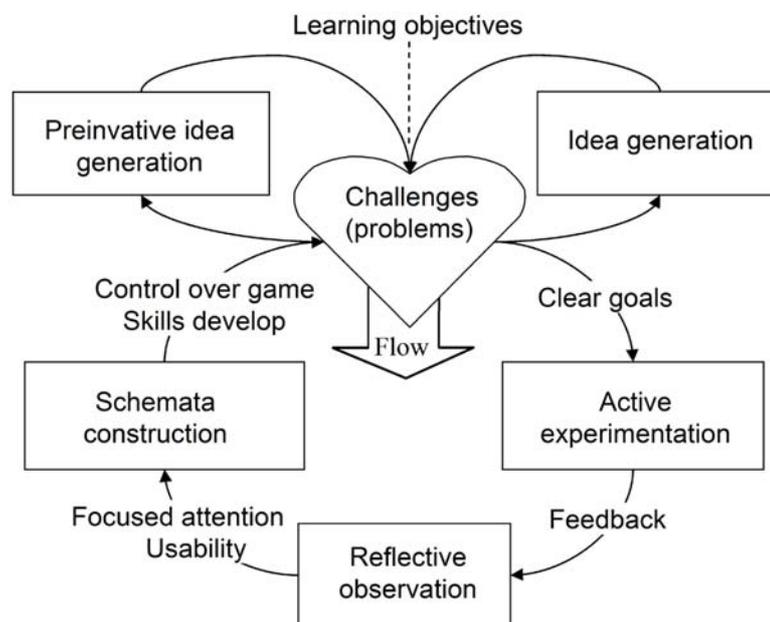
## **6.2 Experiential Learning as a Design Paradigm**

According to Stumpf & McDonnell (2002), recent design literature can be structured around four design paradigms: rational problem-solving, social process, hypothesis testing and experiential learning. The experiential learning model of designing, also referred to as "Reflective Practice" (Schön, 1993), emphasizes the cyclic and reflective nature of the design process. According to Schön (1993), a reflective designer first frames the problem and names the things he attends to within this frame. After the framing phase the designer generates 'moves' toward a solution and finally reflects on the outcomes of these moves. In this process, the designer has two main roles. He functions as both a creator developing a solution and an experimenter trying to understand the overall situation he is creating. Thus, it can be said that the designer has a reflective conversation with the situation that may aid in developing a deeper understanding of the design problem. Surprises stemming from the unpredictability of complex design situations encourage reflective conversation. Furthermore, reflected outcomes of conducted experiments allow the designer to develop a new framing of the situation or new moves. Stumpf and McDonnell (2001) stress that

the experiential design method is applicable in design tasks that obligate the designer to construct the problem. Thus, it is well suited for educational game design and is used as the basis of the experiential gaming model.

### 6.3 The Experiential Gaming Model

In this section an experiential gaming model describing the learning process through games, as well as a game design process, is presented (Figure 13). The main purpose of the model is to bridge the gap between pedagogy and game design. The meaning of factors facilitating flow experience is emphasized. The ambition to design games that enhance experiencing flow is justifiable because previous research has indicated that flow has a positive impact on learning, exploratory behaviour and players' attitudes (Webster et al., 1993; Skadberg & Kimmel, 2004; Ghani, 1991). The game design process is described on a generalised level because the design process may vary between different game genres. The model describes learning as a cyclic process through direct experience in the game world. Both constructivist and pragmatist views of learning are adopted. The model stresses that activity that is necessary for learning is not merely cognitive but also behavioural. Thus, learning is defined as a construction of cognitive structures through action in the game world. The model does not consider gaming either as individual or social activity, because games can consist of both individual and social events.



13. The experiential gaming model

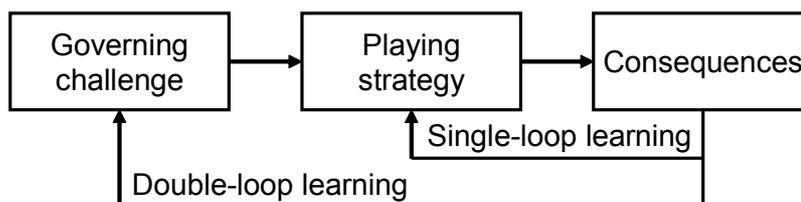
The experiential gaming model is constructed with the help of an analogy between the human blood-vascular system and educational gaming. The model consists of an ideation

loop, an experience loop and a challenge bank. The challenges, based on educational objectives, form the heart of the model. The task of the heart is to sustain the motivation and engagement of the player by pumping appropriate challenges connected by a story line to him or her. To overcome the challenges, a player generates solutions in the ideation loop reflecting lesser circulation. Generation of solutions is divided into a preinvasive idea generation (Finke, Ward, & Smith, 1992) and idea generation. Preinvasive idea generation refers to primary creativity (Maslow, 1963) and can be described as being an unstructured and chaotic phase resembling the play of children. According to Finke et al. (1992), a generation of preinvasive structures may be successfully undertaken without considering the constraints of the system and hopefully lead to innovative solutions. After the preinvasive phase a player further develops solutions by considering the constraints and resources available in the game world. The ideation process is most fruitful if it is performed in groups.

After the ideation phase a player tests solutions in the experience loop reflecting greater circulation and observes the outcomes of actions. The game should be usable and provide clear goals and appropriate feedback to the player in order to facilitate flow experience. Focused attention antecedent refers to game features that aim to support reflective thinking and knowledge construction by focusing players' attention to relevant information from learning point of view. The reflective observation of feedback may lead to the construction of schemata and enable the discovery of new and better solutions to problems. At this point it is relevant to divide gaming into a private and a shared world. A critical question is the transition between these worlds. In online multiplayer games players can collaboratively solve and explore problems in a shared game world, but ultimately critical reflection and knowledge construction occurs in their private worlds. In online learning environments reflection has been facilitated for example with conversation tools, intelligent tutorials (Seale & Cann, 2000) and computer-based tutors (Aleven & Koedinger, 2002) that can also be utilized in educational games. More detailed information on schemata construction is presented in Article 2.

While testing solutions a player's skill level increases and he may achieve control over the game and the subject matter. In fact, the powerful sense of control has been argued to be one of the main reasons why people find computer games so captivating (Ghani & Deshpande, 1994). If the performance of the player is based on only one particular solution, the gaming strengthens only those schemata that are related to this solution. As a result of one-sided activity in the game world, the heart may become exhausted, leading to a reduction in the player's motivation in the long run. Such a one-sided playing strategy refers to single-loop learning (Argyris & Schön, 1974) which is not effective and not a developing learning method because it does not aspire to a better understanding of the problem domain. In other words, chosen goals and playing strategies are operationalized rather than questioned and developed. From a creative problem-solving and

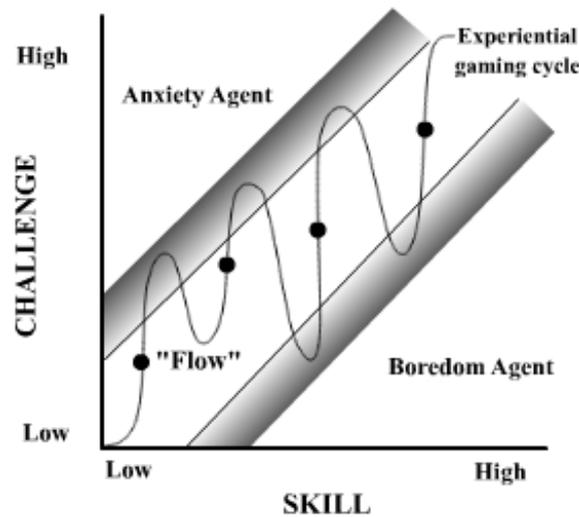
comprehensive learning point of view it is important that the player endeavours to test different kind of solutions in order to expand knowledge on the subject matter and optimize playing strategy. Generally, the task of the ideation loop is to cleanse the experience loop of old solutions by feeding it with fresh creative solutions to be tested and reflected. Thus, the ideation loop of the model supports double-loop learning (Argyris & Schön, 1974) emphasizing the scrutiny of governing challenges in order to generate better solutions and playing strategies. The differences between single and double-loop learning in a game context are illustrated in Figure 14.



#### 14. Single-loop and double-loop learning in game context

The experiential gaming model above was described from a player's point of view. However, the model works almost the same way as a design framework except that the designer constructs the problems. In the terms of Schön (1993), the designer frames the problem and names the things he attends to within this frame, generates solutions, experiments with them in practice and reflects on the outcomes. Furthermore, reflected outcomes of the conducted experiments allow the designer to develop a new framing for the problem or to generate new solutions. Thus, the designing is understood as a cyclic and continuous process. During the design process designers should pay attention to a pedagogical approach, as well as to flow antecedents included in the experiential gaming model. Next one of the most important antecedents, appropriate challenge, is discussed in more detail.

Finally, the meaning of the heart is emphasized. From a learning and motivation point of view, the operation of the heart is essential. The heart should provide a player with challenges that are matched to his or her skill level in order to increase the likelihood of experience flow. Additionally, the tempo of challenges should be balanced with the player's characteristics. The trick of the game is to keep the player in a flow state by increasing the skill level of the game while the skill level of the player increases in order to maximize the impact of them. The adaptive gameflow engine illustrated in Figure 15 could be utilized in this endeavour.



15. The adaptive gameflow framework (agent activation areas are described as grey beams)

The adaptive gameflow engine consists of an Anxiety Agent and a Boredom Agent whose tasks are to support a player's ambitions to achieve the flow state. The operational principle of this engine is derived from a Math Refresher course system presented in Article 6. The wave curve (sine) describes a player's learning process and how the skill-challenge balance keeps changing during gaming. Furthermore, the wave between two dots describes one circle of an experiential gaming cycle which reflects the continuous and cumulative nature of learning. If the challenge is too high, the Anxiety Agent activates and either supports a player's performance (zone of proximal development) or decreases the challenge level. The system can, for example, guide a player to reach relevant information, give hints or suggest collaboration with more advanced players. In contrast, if the perceived challenge is too low, the Boredom Agent can increase the challenge the player is facing. Such manipulation on challenge levels should increase the possibility of experiencing flow and enhance learning because the learning curve becomes sharper. However, it is important to remember that adaptation should be transparent to the player in order to ensure that the player does not change his normal behaviour in the game world. For example, if the player notices that the challenge becomes easier if he performs worse than he is capable of performing, the game engine has failed to provide meaningful challenges to the player. To conclude, the experiential gaming model presented provides only a generalized description of educational game design and there are still several issues that should be considered. The most important of these, storyline, audio-visual elements of the game, and game balance, are briefly discussed in Article 1.

## **PART THREE: THE PROTOTYPE**

## 7 IT-Emperor: An Educational Game on Usability

*“I am the Emperor. My descendants will be numerous. From the second generation to the ten thousandth, my line will not end.”*

The First Emperor of Qin

The IT-Emperor game that was designed with help of the experiential gaming model is presented in this section. This game will be used to evaluate the usefulness of the experiential gaming model. In the development process of IT-Emperor, the author of this thesis worked as the game designer. Game programming specialist, Kai Ojansuu, implemented the game. Before presenting the features of IT-Emperor, the greatest design problems of this artefact building process are shortly discussed, as Järvinen (2004) has suggested.

### 7.1 Design Problems

In this research the major design problem of the instantiation building phase was determining the game genre that supports following requirements:

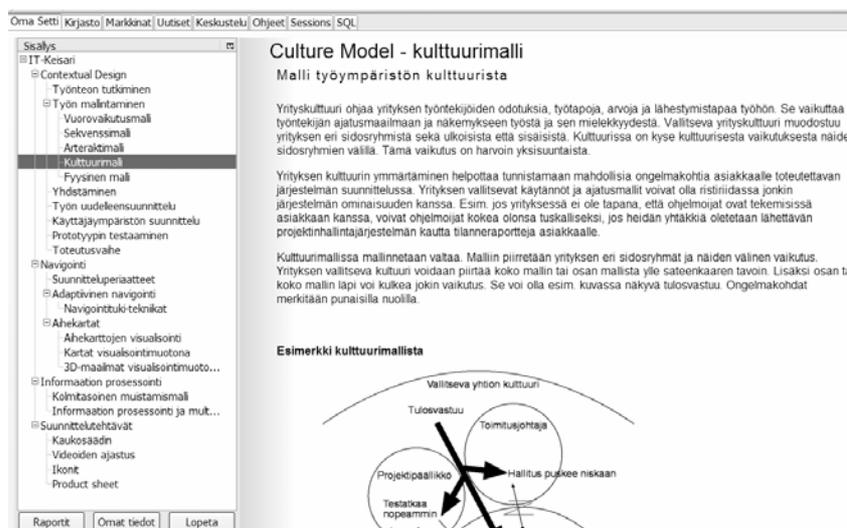
1. The constructed game should be easily modified to other contexts.
2. Challenges should support knowledge construction, creativity and problem-solving.
3. The game should include collaborative activities (knowledge sharing at the least).
4. Reflection should be supported somehow.
5. The flow antecedents included in the experiential gaming model should be supported.

The content management genre (-refers to games where players are challenged to produce content components and manage these components in the game world) was selected because it can be implemented in such a way that the requirements above are satisfied as follows. The first requirement stems from a resource shortage. Game development requires so much effort that the developed game should be easily modified for use in different courses. At the very beginning of this work it was realised that, in order to full fill this requirement, a game engine that can be used to both construct and run games had to be created. The game development began by constructing a dynamic game engine, Emperor. In this development process the author worked as the designer, and Kai Ojansuu coded the engine. Requirements 2-3 stem from constructivism assuming that learning is an active knowledge constructing process where people actively construct their own knowledge through interaction with the environment and other people (Resnick, 1989; Phillips, 1995). In practice, some tools and rules that support collaboration were included

in Emperor. Furthermore, content creation was selected as the main challenge type of Emperor because of the results achieved in Article 2. Requirements 4-5 clearly stem from the experiential gaming model that was used in this design process. Features, such as the prodding system and graphical monitoring tool that can be used to facilitate flow experience, were included in Emperor. Clear support for reflection was not implemented into the game engine, but the tools included can be used to facilitate it. The features of Emperor are reported in more detail in Article 3. Work continued by designing and developing an educational game, IT-Emperor upon Emperor.

## 7.2 A Description of IT-Emperor

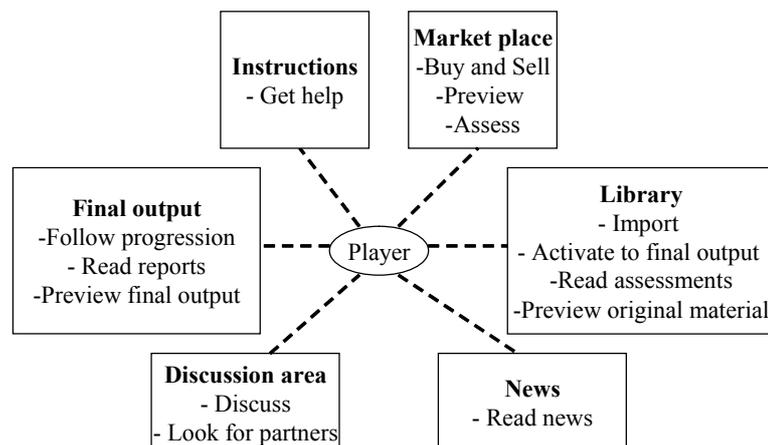
Emperor was selected to rule a usability game called IT-Emperor (Figure 16) in its first period. IT-Emperor is a Web-based educational game where university level students work in a virtual production company as trainees. Players are hired to produce learning material about usability. The game administrator designed the educational experience by defining the content, rules and the activities of the game. In addition to the experiential gaming model a demand-driven learning model (MacDonald, Stodel, Farres, Breithaupt, & Gabriel, 2001) was utilized in the design process. One consideration in particular was the consumer demand of authentic and industry-driven content. As a result, the content of the game reflects the problems and issues that may arise in a production company. In addition, a jury formed from members of different corporations was employed to give feedback to the players about their productions. IT-Emperor can not be regarded as being an authentic learning environment in terms of Gulikers, Bastiaens and Martens (2005), because the game also includes imaginary parts that do not exist in reality. However, IT-Emperor can be characterized as being a semi-authentic environment.



16. A screenshot of IT-Emperor

At the beginning of the game each student had original, poorly designed, learning material about usability. The original material is the unfinished output of an ex-employee who has been fired from the company. The material was divided into 30 content components that can be considered as learning objects about contextual design, navigation, and information processing. Additionally, four design tasks are included. In the game students can either replace the original components with self-made components, or they can buy components that other students have made from the marketplace, if they have enough credits available. Generally, the aim of the player is to produce as good learning material as possible and at the same time earn money in the marketplace.

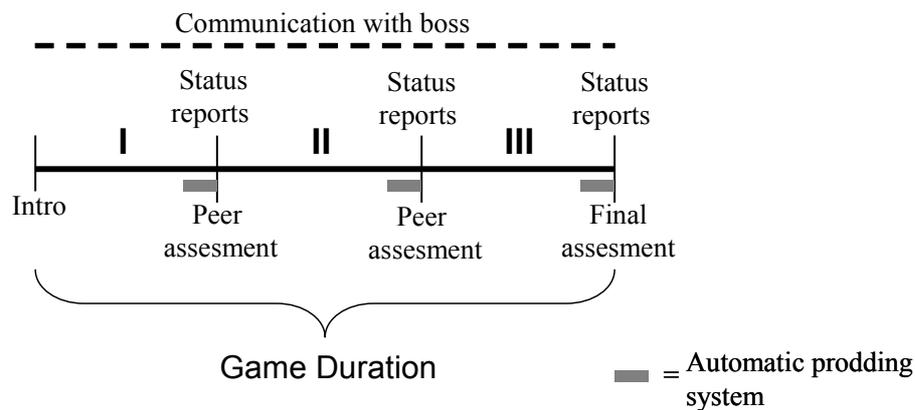
The studying presence is supported by allowing players to produce components collaboratively and by offering a discussion area for players. The purpose was not to make a mechanism that would force players to communicate, but a possibility for that was provided. In addition, players were employed to assess the components that other players had made. This practice ensured that players got more feedback for their productions and all of the players were obligated to familiarize themselves with all the different component types. If a player bought a component of subject matter C, the assessment system ensured that the player was employed to assess at least one C component. Success in the component market and evaluation reports of the company's boss provided a meaningful feedback channel for the players. Finally, the outcomes of the usability project, learning material and banking balance were used to decide what kind of job the trainee achieved in the company. Figure 17 summarizes the actions that a player can perform in a game world.



### 17. Possible actions in the game world

The progression of IT-Emperor is illustrated in Figure 18. In practise the game was divided into three phases in order to boost the progress of the game. Players had to produce and buy components for a certain amount in each phase. When the deadline drew

closer, the prodding system activated and prodded a player to finish required tasks in time. When the phase closed, the game engine created reports of players' performances that were sent to the game administrator and all of the players (personalized reports). From these status reports the game author could follow players' progress in the game and provide guidance if necessary. At the end of each phase the players that had managed best in the marketplace were rewarded with a bonus. Deadlines for each phase guaranteed that actions performed were settled steadily within a two month time interval. Without these deadlines the actions performed would probably have been taken place during the last weeks of the game.



## 18. Progression of IT-Emperor

In IT-Emperor a prodding system was employed to take the role of the players' boss in the production company (i.e. used as a story-forming tool). In addition to an automatic prodding system, the boss sent messages to players manually also. The boss did not only keep the players on the right track by offering guidance and feedback, but could also shake the lives of players by providing new challenges, for example. This made the game more realistic and interesting. Basically, the prodding system aimed to extend the flow channel by supporting the actions of players in the game world.

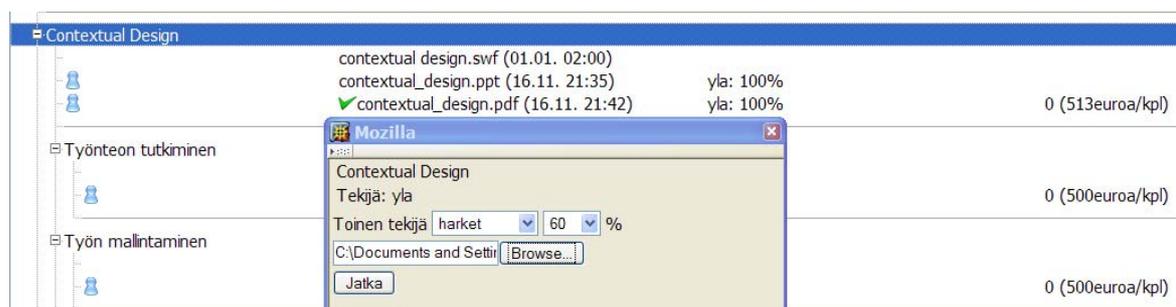
### 7.3 The Story of Player Jules

In this section the different phases and elements of the IT-Emperor are described from player's perspective in the form of a compressed scenario. Although, the story of Jules is fictional it reflects events that occurred during the IT-Emperor game.

In the introduction lesson, the idea as well as the user interface of IT-Emperor, was presented to Jules and other players. In the same lesson, Jules got a password to IT-Emperor so he could start playing the game. First, Jules read the following message that the company's boss had send to him. *"Hello. I am Jaakko Nielsen, the executive director of Usability Oy. Obviously you are the trainee who has promised to save our usability*

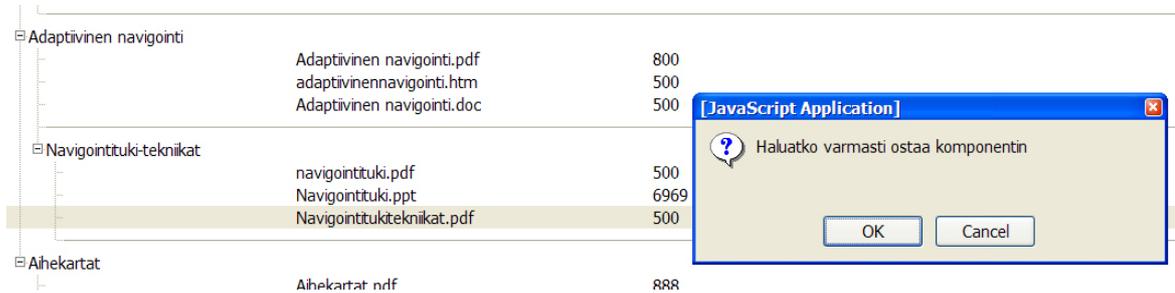
*material project...*”. In spite of the message and the Help section instructions, Jules was a bit confused at the beginning. However, he understood the goal of the game after he had participated in discussions in the game’s discussion forum.

From the discussion board Jules found a player who was willing to produce some components with him. Jules and his partner used the discussion board to design the component, but the lack of appropriate tools for producing the component collaboratively disturbed their playing experiences. For that reason the partners made only one component together and imported it into their libraries (Figure 19). Jules pushed all the components that he had made onto marketplace for sale. Competition in the market place was tough and eventually the market froze because some of the players had imported plagiarized components into the game. The players who had plagiarized content had to pay huge compensations for their copyright offences. Jules decided that he would not even think about cheating because of such high penalties.



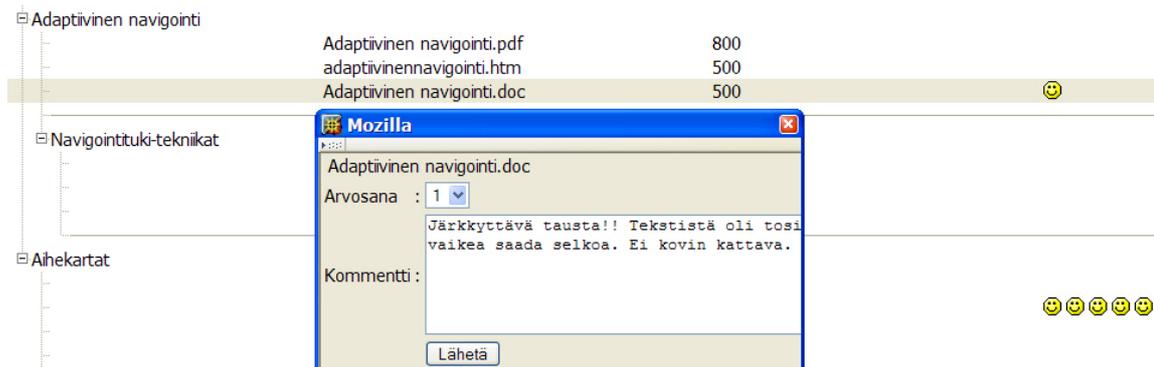
### 19. Importing the collaboratively produced component into the library

The deadline of the first phase drew closer and Jules got a message from the boss indicating that he had not yet completed all the required actions. Jules realized that he had to still buy one component in order to complete the phase. So he went to the marketplace and started to look for a high-quality component dealing with navigation which he perceived as being difficult to complete. Jules found an appropriate component and bought it (Figure 20). After that he checked with the “My Information” section as to how he had succeeded in the marketplace. He had made a few sales and his banking balance had increased. Finally, the deadline closed and Jules got a phase report from the boss indicating that he had completed the first phase. At the same time the message in the public news box informed that he had received some bonuses due to his success in the marketplace.



## 20. Buying a component

In the beginning of the second phase Jules recognized that he had to assess other players' components in the marketplace. He assessed the determined components by giving marks and by writing textual comments to authors (Figure 21). He considered the assessment task as being useful because he got ideas on how he could improve his own productions. After the review session Jules read feedback that other players gave to him and finally started to produce new components. During Phase 2 the boss offered some hints and resources to Jules and he succeeded in performing all the required tasks in time and Phase 2 was completed.



## 21. Assessment form

In the third phase the game continued in same manner. However, the boss wanted Jules to evaluate his working environment (IT-Emperor game) in order to be able to make improvements. Jules filled in the questionnaire and got some credits for his help. In Phase 3 Jules also made a product sheet describing an innovative mouse. He got feedback on his product sheet from the personnel of a marketing company. When the final deadline drew closer, the boss reminded Jules to activate all the components that he wanted to be included in his final material. Jules activated the components and previewed his completed learning material on determined usability issues (Figure 22).

**5. Fyysinenmalli**

*Työ tehdään fyysisessä ympäristössä, joka joko tukee työn tekoa tai häiritsee sitä. Jos esim. ohjelmasta tulostetaan usein fyysisiä raportteja, on tulostimen sijoitettava lähellä ohjelman käyttäjää. Fyysinen ympäristö asettaa näin ollen järjestelmälle tiettyjä fyysisiä rajoitteita.*

- Malli esittää ympäristön asettamat rajoitteet suunnittelulle
- Mallissa voidaan huomioida myös henkilöiden välinen kommunikointi ja onko vallitseva fyysinen ympäristö sille suotuisa
- Malliin merkitään kaikki työn kannalta olennaiset elementit (ei toissijaisia elementtejä, kuten huonekasveja)
- Lopuksi kuvataan henkilöiden kulkureitit eri elementtien välillä (ongelmakohdat pun.salamalla)

The diagram shows a workstation layout with elements: 'puhelinluotto/arkisto' (phone credit/archive), 'työpöytä' (desk), 'puhelinlaika' (phone time), and 'tulostin' (printer). A red lightning bolt indicates a problem area between the printer and the phone time element.

## 22. Previewing the completed material

When the deadline had closed, the productions of players were evaluated and they got grades from the course. Their playing performance determined the job that they got from Usability Oy. For example, Jules was hired to work as a project manager after the training period.

## **PART FOUR: EVALUATIONS**

## **8 Results and Conclusions**

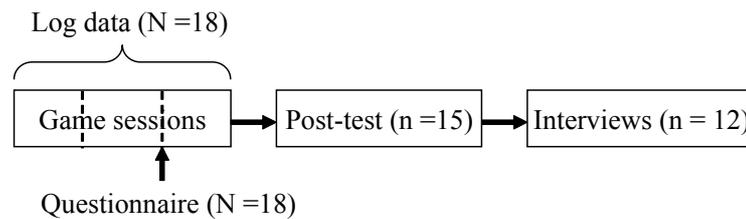
This is the final section of this thesis which aims at binding all the threads together. The main objective of this thesis was to construct a game design model that integrates both educational theory and game design aspects into a solid entity facilitating flow experience. In this section, the constructed experiential gaming model (section 6.3) will be evaluated and further developed in two stages. First, evaluation is conducted through the study of IT-Emperor and achieved evaluation results are used to revise the experiential gaming model. Secondly, the revised model that is the final outcome of this thesis is evaluated with the help of two problem-solving games presented in Article 6. The aim of this evaluation is to validate the flow antecedents included in the experiential gaming model. Finally, conclusions and directions for future research are presented.

### **8.1 Summary of the First Evaluation**

In order to study the usefulness of the experiential gaming model, an educational game, IT-Emperor was developed and evaluated. Following are the main research questions used in this evaluation:

1. How did players experience the use of IT-Emperor in the usability course?
2. Can content creation challenges be utilized in educational games?
3. Did IT-Emperor cause flow experiences to players? Furthermore, what were the main activities that created flow in IT-Emperor?
4. What are the obstacles to flow in educational games?
5. Did the flow experience positively affect learning in IT-Emperor?
6. Was the experiential gaming model useful in the design process of IT-Emperor?

Several data collection methods outlined in Figure 23 were used. The results are not analyzed on the basis of independent variables gathered in the questionnaire for the following reasons. First of all, all the players had used Web for over 5 years and reported using it daily. Secondly, the gender breakdown was biased. Thirdly, Because of the small sample size the educational background cannot be used without revealing participant identity. The More detailed information on methods used can be found from Section 2.



## 23. Data collection in IT-Emperor case

### 8.1.1 Question 1: How did players experience the use of IT-Emperor in the usability course?

Before the IT-Emperor was started an introduction session concerning the use and aims of IT- Emperor was held. At the beginning the participants were confused and they were quite skeptical about the new course arrangement. However, after a few hours of familiarization, most of the players understood the idea of the game and the prejudices against it dropped off. In the end IT-Emperor aroused interest among participants since 15/18 players reported that they were in fact interested in the game. For example, player X felt that

*“From a learning point of view, the game is a nice change from traditional courses because courses like this have not been offered before”.*

However player Y felt exactly the opposite,

*“The feeling of playing is confusing. The whole game feels so complicated and laborious”.*

Although most of the players liked the game, two students would have liked to complete the course in a more traditional way. In fact, four players also reported that the game was too broad in scope and took too much time to complete. For example, player A stated that,

*“There is too much work. The components in the market place are so trashy that I should make all content components myself, but I do not have enough resources for that”.*

Those players that felt the game was too laborious did not grasp the whole idea of the game. Generally, one aim of the game was to simulate a situation where the player is obligated to optimize all available resources in order to get the job done. Sometimes one has to make compromises and accept the best of half-baked outputs available. The confusion induced by unclear instructions on the idea of component trade may have negatively affected the experiences of players. However, some of the players used the discussion area for figuring out unclear issues. For example, player O wrote:

*“I am getting the idea of this exercise. In fact, it is quite revolutionary. Hopefully you paid attention to the fact that the task is not to create user interface components, but content components...”*

Results indicate that students have positive attitudes about the utilization of games in education if they are useful and introduction is carefully designed. An important finding was that students do not demand masterpieces with amazing graphics and sound effects, but they are satisfied with games that offer interesting challenges, problems and stories. Such games do not require huge resources and even educational communities can afford them.

### **8.1.2 Question 2: Can content creation challenges be utilized in educational games?**

This question was studied in two phases and relates to Articles 2 and 4. The aim of the first phase was to study content creation as a learning strategy, in general. First a control experiment studying the effectiveness of student-generated illustrations was conducted. Finnish elementary school students (N=187) learned about the human immune system by interacting with multimedia learning materials. Students performed better on a retention test when they generated their own illustrations by drawing and when explanations were presented as animations, compared to students who received only textual material or generated illustrations from images offered.

The drawing tasks worked as a good pedagogical strategy to encourage learners to think more deeply about the subject matter. While drawing illustrations students had to organize information and make connections between concepts leading to more elaborate and better organized knowledge structures. The results of the drawing condition are consistent with earlier studies (Hall, Bailey & Tillman, 1997; Stern, Aprea & Ebner, 2003; Kafai, Ching & Marshall, 1997; Mitchell, Andreatta & Capella, 2004) indicating that when instructional design requires learners to produce part of the learning materials, then the processes employed to produce these materials are likely to engage students and enhance learning if the challenge of performed activity is appropriate.

The first phase indicated that content creation can be an effective learning strategy. In the second phase, the effectiveness of content creation challenges was studied in a game context. The challenges included in IT-Emperor were broader than in phase one and also required problem-solving and information-seeking activities. According to the log-files players produced 414 components altogether. Surprisingly, only 1.5 % of the components were made collaboratively. Ironically, players who reported that the game was too laborious did not utilize the possibility of producing components collaboratively. The main reasons for that were the fact that one had to share the profits of the components sold in the marketplace as well as a lack of tools supporting collaborative content

creation. Thus, the Emperor needs to be supplemented with tools allowing players to work simultaneously on the same document. Generally, the level of the components varied a lot. However, a trend in which the produced components improved when the game proceeded was found.

It seems that players of IT-Emperor were engaged in creating content which is positive because 16/18 players experienced content creation as being an effective way to learn things. For example, player X stressed that the game was effective from a learning point of view,

*“By creating content one can learn things without noticing it”.*

The results of the post-test supported this experience. Players performed significantly better on the game-based task ( $M = 4.6$ ,  $SD = 0.706$ ) than on the control task ( $M = 2.25$ ,  $SD = 1.004$ ),  $t(14) = -8.612$ ,  $p < .001$ . This result is consistent with the findings of earlier studies (Hall et al., 1997; Stern et al., 2003; Kafai et al, 1997; Mitchell et al., 2004).

However, one problem of the content creation challenges was plagiarism. A few players plagiarized content from the Internet and tried to sell it to other players. Fortunately player B informed on that problem as follows

*“The idea of the game was ruined in the first week by a player who put many very cheap and plagiarized components on the market. Now all the components are cheap because nobody buys expensive ones”.*

Previous research indicates that plagiarism is a significant problem in higher education and that the magnitude of the problem has increased in recent years (Austin & Brown, 1999). The use of computers has made plagiarism easier since word processing programs allow students to easily “cut and paste” information from the Internet. On the other hand, plagiarism is also easier to notice. In IT-Emperor, players who plagiarized content had to pay compensation for their copyright offence. Although plagiarism is an unfortunate issue, a game is a good context for handling these offences against copyright so that students can understand the seriousness of their behaviour in life-like situations. In order to guarantee an equal playing experience for all players, a checking system for plagiarism will be included into Emperor.

In conclusion, content creation can be regarded as being a promising challenge type for educational games. Such challenges are engaging, effective and do not require huge resources for development. For example, the material included in IT-Emperor was quite simple at the beginning of the game. The work of the game administrator was emphasized by constructing the context and the story of the game.

### **8.1.3 Question 3: Did IT-Emperor cause flow experiences to players?**

Post test revealed that only 8/15 players had experienced flow while playing IT-Emperor. Six players experienced strong flow experiences and 2 experienced medium flow experiences while playing the game. Generally, almost all the players had experienced flow as a state where time distorts and they could focus their attention on the task at hand, resulting in a feeling of enjoyment. Most likely the description of flow experience included in the post-test affected this.

Content creation was reported as the main activity causing flow experience, but also action in the marketplace was reported as being a flow-inducing activity. Surprisingly, information seeking, that Chen et al. (1999) identified as the most important flow activity, was not mentioned in this study. Players probably considered information-seeking as part of content creation which may explain this difference.

### **8.1.4 Question 4: What are the obstacles to flow in educational games?**

There were some usability problems in IT-Emperor that interfered with the players' experiences. Only 3/18 players stated that usability problems did not disturb their playing experience. Most of the usability problems in IT-Emperor were only cosmetic and did not cause bad confusion or serious usage problems. However, players identified bad usability as being the major obstacle that inhibited flow in computer-mediated environments, including games. According to player X,

*“Bad usability breaks the flow experience down because one has to concentrate on using the system -not for example, solving a problem”.*

Furthermore, player O compared bad usability to bad playability.

*“I have not experienced flow in games where playability has been bad. In order to be able to experience flow, the game should be easy to control, so that the controls are apparent to me.”*

These results are consistent with Pilke's (2004) findings indicating that user interface that requires less cognitive processing facilitates flow experience. Generally, the aim of an educational game is to provide students with challenges related to the main task, not to usage of the user interface. When both the task and usage of the user interface are complex, then the artifact and the task may detract from the user's attention. Bad usability decreases the likelihood of experiencing task-based flow because the player has to sacrifice attention and other cognitive resources on inappropriate activity. In an ideal situation user interface is transparent and allows a player to focus on higher order tasks. Furthermore, bad usability and inconsistencies in the game world may disturb a player's suspension of disbelief. In other words, usability problems may break the magic circle

down and a player may lose the sense of a second reality, the fictional game world. When suspension of disbelief is lost it is hard to achieve again.

In addition to bad usability, insufficient skills, slow feedback and low gamefulness also came up in interviews as obstacles to flow. Players stressed that challenges have to be matched to a player's skills in order to experience flow. For example, player P stated,

*“If the content of some course was so difficult that I did not understand anything in the first two lectures, I would probably drop out from that course.”*

Accordingly, another player stated,

*“Some of the players involved with online action games are so professional that novice players such as I am easily become anxious and stop playing.”*

However, the challenge that IT-Emperor provided was regarded as being an appropriate one. Generally, the relationship between skills and challenges can be considered as being the main factor contributing to flow experience (Csikszentmihalyi, 1991). Player K saw that adaptation to a user's skill level could be utilized in learning materials more widely in order to maximize the possibility of experiencing flow. Although research on adaptive learning games (Ketamo, 2002) has been conducted, no research on adaptive learning materials in a flow framework could be found. The challenges of IT-Emperor were quite open, making a system that adapts to a player's skill level not necessary. The role of adaptive systems in a flow framework is discussed in more detailed in Article 5 which shows one example of how to apply the ideology of experiential gaming model in more traditional learning environments.

Players also regarded low gamefulness as being an obstacle of flow in educational games. The term gamefulness reflects the complicity of the gameplay events and the level of freedom. The main gameplay event in IT-Emperor was activity in the marketplace, which was not adequate for all players. The experience of most of the players was that IT-Emperor did not offer enough possibilities to use money acquired in the marketplace, resulting in decreased motivation in the long run. For example Player N mentioned that

*“In the first phase activity in the marketplace motivated a lot, but the motivation sputtered out due to the few possibilities of using earned money”.*

Accordingly player K argued that

*“The rewards of a course grade number did not motivate me to strive for success in the marketplace. If success made the game easier for me somehow, the situation might have been different. Now, the game reminds me too much of math courses where one gets points from exercises done...One solution to this problem, would be to provide players the possibility of buying bricks, in order to build a block of flats, for example. The size of the building could reflect success in the*

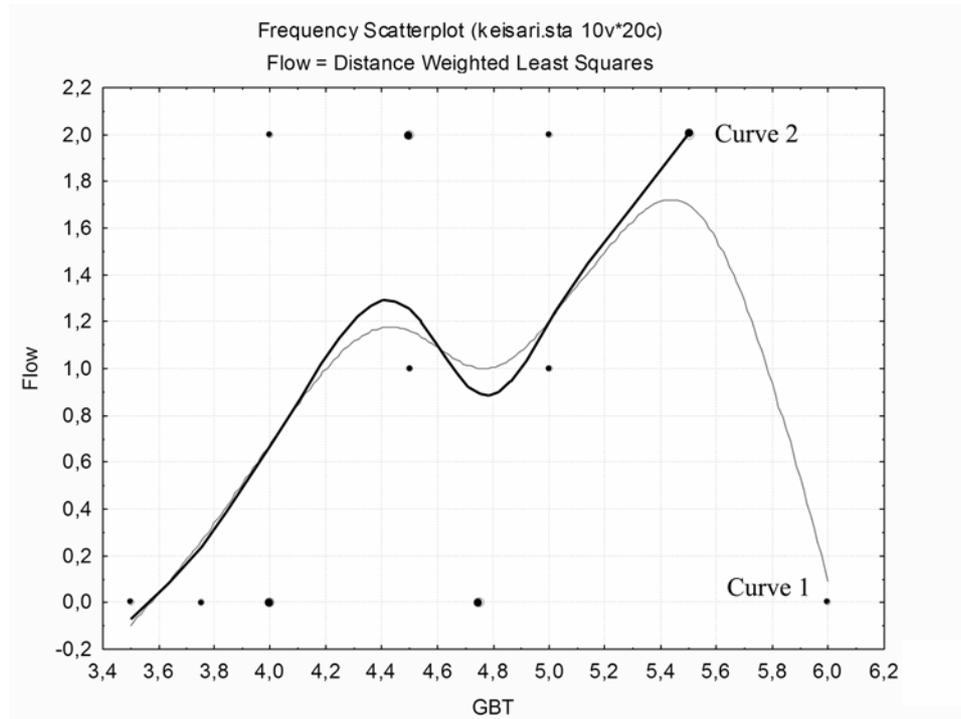
*marketplace.”*

These statements indicate that players appreciate games that arouse intrinsic motivation related to an autotelic dimension of flow experience. This finding is very important because it points out that games can be successfully utilized in education, if the game format is well designed. However, more attention has to be paid to designing the gameplay events of educational games. In this research, the author was aware of the low gamefulness, but due to inadequate programming services (no funding), the game engine used did not support more complex games.

Furthermore, a few players mentioned slow feedback as being an obstacle to flow that is consistent with Skadberg's and Kimmel's (2004) flow model. In this research, some of the players played IT-Emperor with low capacity computers and therefore the largest components loaded quite slowly, which disturbed the playing experience of these players.

#### **8.1.5 Question 5: Did flow experience positively affect learning in IT-Emperor?**

According to previous studies, flow tends to bring about learning (Ghani, 1991; Skadberg & Kimmel, 2004). In order to test this proposition, the connection between a player's flow experience (2 strong, 1 medium, 0 none) and performance on the game-based task (GBT, 1-6 points) was studied. This connection can be seen from distance weighted curves (Figure 24). Curve 1 indicates that the connection between flow and learning is weak. However, the player who got 6 points from the game-based task is an outlier and distorts the curve. The outlier's attitude toward the game was very negative from the very beginning so there is justification to remove this player from the analysis as being an exception. Curve 2 shows the same relationship without the outlier.



24. The relationship between a game-based task (GBT) and flow experience (curve 1: n = 15, curve 2: n = 14)

We can see that Curve 2 is ascending which refers to a strong connection between flow and learning. The correlation between these variables was significant ( $r = 0.552$ ;  $p = 0.041$ ). Strong correlation supports the results of previous studies, indicating that flow has a positive effect on learning. However, the sample of this study is so small that these results cannot be generalized for other groups of people. Hence, more research on this topic is required.

### 8.1.6 Question 6: Was the experiential gaming model useful in the design process of IT-Emperor?

This question is considered at two levels; the design decisions made by the author and the experiences of players on flow antecedents included in the model. Generally, the aim of the model was to provide ways to integrate pedagogy and game design aspects in order to design game features that support the flow experience in IT-Emperor. A questionnaire and interviews were employed to examine how well the author succeeded in this ambition.

The model does not provide certain challenge types to be utilized, but the designer is obligated to form gameplay events from challenges that are appropriate for the context at hand. The main challenge type in IT-Emperor was content creation which was justified through the empirical study (Article 2). Because the nature of content creation challenges is quite open, players could self determine their goals within certain limits, what they

were aiming for? According to Csikszentmihalyi (1991) such practice characterizes creative activities at the least. Thus no adaptive system was included. The author tried to extend the flow channel by providing players with information and hints on subject matters that seemed to be problematic and by allowing collaborative content creation (zone of proximal development). However, the game world lacked appropriate tools for collaborative content creation and collaboration between players was rare. Thus, new tools needed to be developed. Generally, the interviews pointed out that the challenges that the game provided were appropriate and quite well matched to the players' skill levels.

The idea and the rules of the game were simple, but in order to avoid misconceptions an instruction section was included in the game. In spite of that, a few players experienced difficulties in perceiving the higher level goals of the game. The prodding system, among other things, was used to help players to reach the goals of the game. All in all, most of the players reported that the goals of the game were clear and well understood.

11/12 of the players felt that the amount of feedback delivered was adequate. For example, player B liked the reports that Emperor generated,

*“The phase reports are useful. Also the messages from the boss are useful because one always knows what the status of the course is and what has to be done”.*

However, some of the students pointed out that games, including IT-Emperor, where the feedback loop is too long do not induce flow experience. Arrangement of faster feedback on created content components is problematic in games like IT-Emperor because the problems are ill-structured and feedback cannot be delivered automatically. Also including challenge types that can be automatically checked could solve this problem. One of the players experienced that awarding the best salesmen in each phase with a bonus is unfair because such players also get money from sold components. This is a question of game balance which is quite a difficult issue. The bonuses did not affect the balance between players because each player was considered to be an individual player whose banking balance did not affect activities in the game world in any way. (The original banking balance was adequate to make required investments.). Additionally, each phase was dealt with separately and sales were adjusted to zero after each phase. Furthermore, rewarding the best salesmen -even if it would have made a player's activity easier in the game world, is reasonable because similar methods are in use in real life. The other problem related to game balance was plagiarism which needs to be reduced in the future. In practice a system that checks the imported textual components will be developed.

In order to support reflection in IT-Emperor some hints and discussion topics were included in the original components made by the ex-employee of the production

company. The aim of them was to arouse reflective thinking and guide players to consider the most relevant aspects on the subject matters. Players experienced these hints as being useful.

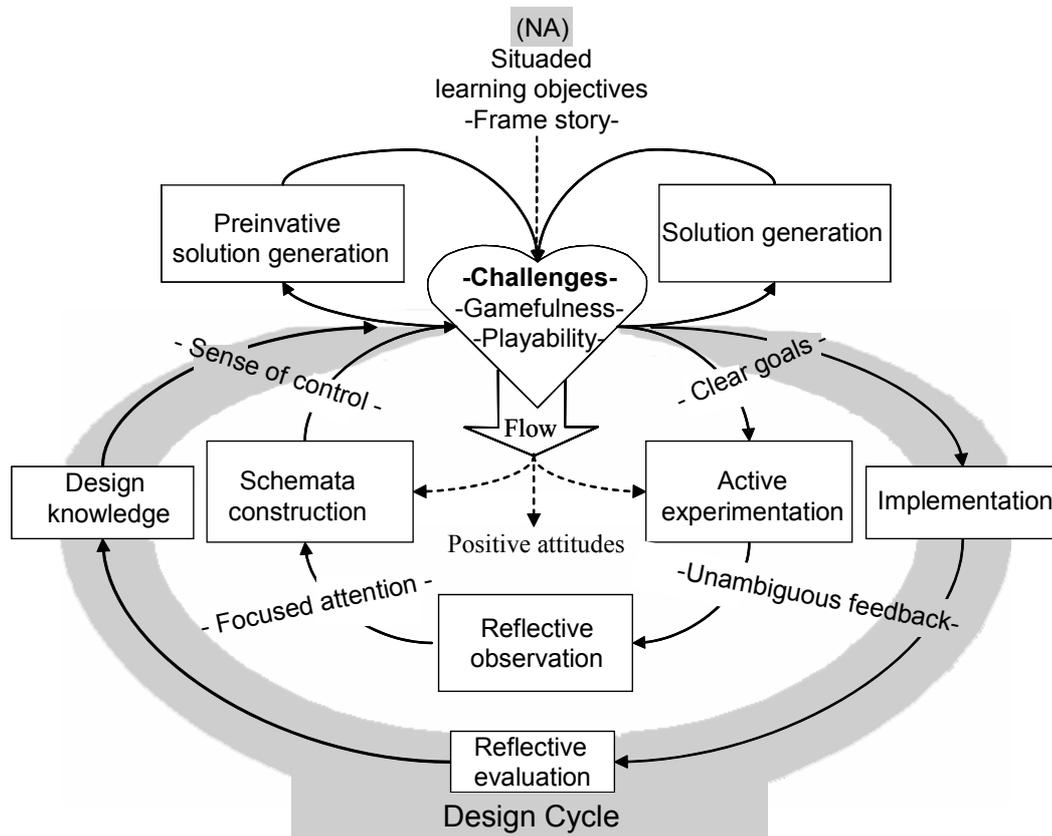
Ironically, the most negative feedback was given from usability problems occurring in the game. As mentioned above, the usability problems were quite small and did not induce bad confusion among players. However, the meaning of these problems was emphasized because the game was integrated into a usability course. In spite of some usability problems, 14/18 players stated that they could focus their attention on the game and concentrate on playing. Furthermore, 12/18 players felt that they could achieve control over IT-Emperor. However, the too linear nature of the game, that can be associated with a sense of control, was experienced as being a problem. Players felt that the game world restricted too much their actions and did not provide enough possibilities. It is true that games of progression where a player has to accomplish a predefined set of challenges in order to complete the game negatively affect the sense of control, but such games are much easier to develop than games of emergence, and they do not require huge resources. Additionally, in games of progression a game designer can ensure that every player faces certain challenges that are necessary to achieve control over issues included within the game. This justifies the use of progressive structure in low budget educational games like IT-Emperor. However, in the future the game engine will be further developed to also support games of emergence.

Overall, these results indicate that IT-Emperor provided an environment for players where experiencing flow was possible. In fact, 8/15 players experienced flow while playing IT-Emperor. In that sense the model was successfully utilized in the design process. However, the model describes only the main elements that should be considered in educational game design and does not offer solutions or guidelines to a whole game design and development process. The model would be more useful if it also took these processes into consideration in some sense. Furthermore, the evaluation results of IT-Emperor revealed several factors that should be included in the model. Thus, in the next section a redesigned experiential gaming model will be presented as the final outcome of this thesis.

## **8.2 The Experiential Gaming Model Revised**

The most important contribution of this research is the experiential gaming model that can be used to design and study educational games and gaming. In this section, a revised version of the model fulfilling the main objective of this thesis is presented (Figure 25). In order to support the work of educational game designers, the model is extended with the design cycle. Now the model is more useful in educational game design and the development process because it not only describes the learning process with games, but

also contributes to the whole game development process more concretely than the first version of the model. In addition to the design cycle, some flow antecedents and consequences have been added to the model. In spite of these changes, the basic ideology of the model is the same as described in section 6.3 The changes made are considered next from both the viewpoints of the gaming process and the design process.



25. Experiential Gaming Model (NA = needs analysis)

### 8.2.1 Changes in the Gaming Cycle

The main purpose of the gaming cycle is to provide a description of the gaming process and learning process in games. It aims to focus the efforts of designers on the most important factors influencing the gaming experience and learning with games. The meaning of the story that integrates the challenges into a certain context is highlighted by adding a frame story antecedent to the model. The situated learning theory supports this view by stressing that learning is a context-dependent activity (Brown, Collins & Duguid, 1989; Lave & Wenger, 1990). Thus, especially in higher education, games should consist of situated challenges that are practical and relevant to real life. For example, the frame story of IT-Emperor was formed around a production company. Another meaning of the frame story is to support the formation of magic circle.

The focused attention antecedent needs to be defined more precisely. In this model focused attention refers to game features that aim to support reflective thinking and knowledge construction by focusing the attention of players to relevant information from a learning point of view. For example, Math Refresher course system (Article 5) focuses a player's attention on the task-based theory relevant to solve the exercise at hand. Furthermore, the task-based theory is sorted from the most important issues to the less important ones according to a learner's skill profile. Such a system helps a learner to concentrate on relevant information and reduces the extraneous cognitive load and increases the germane cognitive load needed for knowledge construction.

The usability antecedent of the model is replaced with concept playability, which is more appropriate to the game context. In fact, playability includes a whole new set of aspects compared with usability that should be considered in game design. Generally, playability refers to guidelines regarding how to implement a desired sort of gameplay (Järvinen et al., 2002). It consists of 1) functional, 2) structural, 3) audiovisual, and 4) social components as described in Section 5. In a nutshell, functional playability concerns the functional variables that affect gameplay. Educational games in particular should be easy to control in order to release cognitive resources for higher order tasks.

Distributing structural playability at a micro-level and at a macro-level is relevant in educational games. Micro-level structures refer to actual gameplay events which require a player to focus his cognitive resources into playing the game. The term gamefulness, reflecting the complicity of the gameplay events was added to the heart of the model, because low level of gamefulness, was considered as being an obstacle of flow experience in IT-Emperor. It is important to notice that gamefulness also concerns the gains of the game, which should be constructive and linked to gameplay events. On the other hand macro-level structures refer to instructions, task briefings and such activities that do not include interactivity. In designing macro-level structures designers should utilize animations if possible due to results presented in Article 2 indicating that well implemented animations were more effective than student-generated materials and textual information provided to students. The challenge is to find a balance between micro-level and macro-level structures so that the whole gaming experience is enjoyable and a player does not feel a sense of losing control over the game world.

Generally, audiovisual playability is tied to functional and structural components that should support one another. For example, dimensionality and point of perception of the game affect the implementation of functional playability. In an educational setting, what kind of audiovisual implementation is appropriate should be clearly considered. The audiovisual style and appearance of the game influence the experiences of players and should be targeted to a certain audience segment (Järvinen et al., 2002). An important finding of this research was that students did not demand audiovisually complex games,

but they are satisfied with games that offer interesting challenges and stories, rather than audiovisual oriented games. Such games do not require such great resources and even educational communities can afford them. In designing audiovisual playability, designers of educational games should consider the cognitive load theory and the multimedia learning issues discussed in Article 2.

The social playability component is used to consider appropriate social practices in the game world. In order to maintain a community of players, a game should provide functionalities that encourage community formation and support the creation of co-experiences. In other words, players should be able to share knowledge and opinions in the game world. The results of IT-Emperor pointed out that a basic discussion area can be utilized in off-game communication, but it is not an adequate tool for communication taking place during gameplay events. The players of IT-Emperor requested more appropriate tools for supporting collaborative content creation synchronously. For that reason game designers should provide appropriate tools supporting the aims of gameplay events in order to achieve the desired playing patterns.

Furthermore, the model is supplemented with flow consequences: learning, positive attitudes and exploratory behaviour described by dashed lines in the centre of the model. The results of IT-Emperor support the learning consequence, but the connection between flow, positive attitudes and exploratory behaviour were not studied directly. However, interviews revealed that players of IT-Emperor looked on the game positively and tended to examine other players' productions in the market place. Flow consequences, positive attitudes and exploratory behaviour are included in the model based on earlier research (Webster et al., 1993, Ghani, 1991; Skadberg & Kimmel, 2004). In the game context, exploratory behaviour can be understood as being an exploratory experimentation of game features and generated solutions.

### **8.2.2 The Game Design Cycle**

Generally, game development requires huge resources that most educational institutions cannot afford. The ideology of the formative development method (Suhonen, 2005) that promotes cost and time efficiency was applied in the experiential gaming model. The aim of the design cycle is to guide and facilitate the work of designers. The design cycle describes the main phases of game design in very abstract stages because the design process may vary between different game genres. Furthermore, such an approach is reasonable because according to Crawford (1984), game design is far too complex an activity to be reduced to a formal procedure.

The game design cycle starts with a needs analysis (NA) which aims to identify the needs of the learners and design solutions. The solution loop of the model describes the progression of the needs analysis. In the preinvasive solution phase a designer tries to

develop the most creative solutions possible. These solutions are developed more in the solution generation phase by taking flow antecedents, contextual factors, instructional design principles, and other constraints into account. After that the generated solutions are implemented as soon as possible in order to enable early experiments with players. Fast prototyping provides designers with a fast turn-around to refine the game features implemented (Clement et al., 1999; Moonen, 1996). Generally, prototyping provides opportunities for end-users to incorporate in the design process. It is important to note that the aim of the experiential model is not to produce perfect results instantly, but development of the final product may take several iterations.

In the reflective evaluation phase the experiments conducted are evaluated. The focus is on the game world analysis and experience analysis. In the game world analysis the use of game features are evaluated. For example, in the IT-Emperor case both log files and interviews were employed to study the use of included features. The aim of the experience analysis is to examine the players' experiences, feelings and perceptions on the game in order to reveal novel ideas for the design process. An experience analysis is done in the flow framework focusing on flow antecedents, flow experience and flow consequences. Flow scales tested in Article 6 can be used in this endeavor. Feedback received from players may be harsh because of the fast prototyping ideology. However, all results should be analyzed in a constructive manner and documented well in order to be able to use them later as reference material in a needs analysis. In fact, Nievergelt (1980) argued that computer-assisted instruction is a field where experience and common sense are the only guidelines. The model agrees partly with Nievergelt's argument by considering educational game design as being a cyclic process which enables the productive re-use of constructed design knowledge. Table 2 summarizes the phases of the design cycle with examples of the main tasks, possible methods, outcomes and risks of each phase.

Table 2. Summary of phases of the design cycle

	<b>Needs Analysis</b>	<b>Implementation</b>	<b>Reflective Evaluation</b>	<b>Design Knowledge</b>
<b>Task</b>	Identify needs and form creative design solutions	Implement design solutions	Evaluate solutions in order to find viable ones. Deeper understanding	Construct design knowledge of tested solutions
<b>Methods</b>	Analysis of flow antecedents, instructional design principles, and contextual factors	Fast prototyping	Game world and experience analysis	Report both successful and unsuccessful solutions
<b>Outcome</b>	Pedagogical, technical and psychological design principles and solutions	Flow inducing educational game	Information of the features of the game world and users' experiences	Design exemplars for Furthermore needs analysis
<b>Risks</b>	Incorporation of pedagogical and game design aspects in a meaningful way	Too early exposing to players	Inappropriate methods: faulty conclusions	Lack of contextual documentation. Transferability.

So far this section concentrated on the design process of the model. The aspects of the experiential gaming model facilitating designers work are discussed next. The possibility to experience flow is not only the exclusive right of players, but designers also can experience it in their work. In fact, the findings of Csikszentmihalyi (1975) state that designing or discovering something new resembles flow activities. One aim of the experiential gaming model is to support the work of game designers so that also they can experience flow in their work. In the experiential gaming model some of the flow antecedents are extended to also consider the design cycle. Just like players, designers and developers should have clear goals on what they intend to do and get immediate feedback on their work. The challenges laid should correspond to their abilities. Designers should be able to sense control of their work process and focus their attention to relevant problems of the design domain. It can be argued that flow inducing design methods and practices are key issues also in promoting the cost and time efficiency of the design process, as well as in the implementation of creative design solutions.

### 8.3 Summary of the Second Evaluation

The evaluation results presented in this section are based on Article 6. In order to study the usefulness of experiential gaming model as a design framework, two problem-solving games were developed and evaluated. The main purpose of this work was to validate the flow antecedents included in the experiential gaming model and to study their influence on flow experience. Additionally, the study aimed to operationalize the flow construct in a

game context and to start a scale development process to assess flow experience in game settings.

The evaluation of the experiential gaming model was carried out through two experiments involving two problem-solving games. The model turned out to be useful in extending a traditional Japanese crossword to a more gameful entity. The results of both experiments supported the splitting of flow dimensions into flow antecedents and flow experience. Concentration, time distortion, autotelic experience, and loss of self-awareness (used only in experiment 2) dimensions were found to be indicators of flow experience. The reliability of the constructed flow experience was found to be satisfactory (game 1:  $\alpha = .93$ ; game 2:  $\alpha = .74$ ). In both experiments these dimensions together reflected the players' experienced flow level. Table 3 shows the relationship of studied flow antecedents and flow experience in both experiments.

Table 3. Correlations between flow antecedents and flow experience (N = 278)

		Challenge	Goal	Feedback	Control	Playability	Frame story
Experiment 1 (n=57)	Flow exp.	.735 p = .000	.365 p = .005	.538 p = .000	.526 p = .000	.538 p = .000	.400 p = .002
Experiment 2 (n=221)		.313 p = .000	.277 p = .000	.296 p = .000	.471 p = .000	.314 p = .000	not measured

The table shows that all correlations are significant which supports the existence of these antecedents in the experiential gaming model. According to these results educational game designers should consider these antecedents when trying to design flow inducing games. Next some of these antecedents are discussed in more detailed. Playability and a frame story are new flow antecedents that have not been proposed before. However, playability has clear roots in the action-awareness merging dimension and usability. The action-awareness merging dimension is problematic from the educational games point of view. While the ultimate aim of educational games is to support knowledge construction requiring conscious processing, it is the opposite of the idea of this dimension. Thus, in an educational game context the action-awareness dimension is applied to usage process of the game interface associated with playability. Such practice is consistent with the ideology of the PAT model (Finneran & Zhan, 2003).

The role of the frame story turned out to be significant in game settings. In authentic learning games such as Realgame (Lainema, 2004) or IT-Emperor, the meaning of the frame story is emphasized. An important lesson of this study was the fact that even minor things that break down the harmony of the game can ruin the whole playing experience. For example, in game 2, an annoying sound effect disturbed players' experiences and inhibited flow experience.

Gamefulness and focused attention antecedents included in the experiential gaming model were not studied because the games used were too simple for that. Although the aim of this study was not to study flow consequences, some deductions about the relationship of flow experience and positive attitude can be made. The correlation between flow experience and positive attitude consequence was found to be very significant ( $r = .455$ ) which support the assumption of the experiential gaming model, arguing that flow has a positive influence on player's attitudes.

The work presented in Article 6 is a part of an ongoing attempt to develop a usable and valid scale for assessing the flow experience of players in educational games. The results of both experiments demonstrate that both Flow Scale 1 and Flow Scale 2 provide satisfactory and useful tools for assessing the gaming experiences of players. These flow scales can be utilized in the reflective evaluation phase of game design cycle. However, the scale development process is still at the very beginning. The next phase is to combine these scales and develop an extensive, but short, questionnaire to be used in an experience sampling method in a game context.

## **8.4 Conclusions and Directions for Future Research**

### **8.4.1 Conclusions**

In this research educational games are understood to be games designed to support players' studying and learning ambitions, rather than merely being entertaining. The thesis presents the construction process of an experiential gaming model that can be used to design and study educational games. The final version of the model presented in Section 8.2 has three main goals. First of all, it describes the learning process through games relying on an experiential learning theory, constructivism and a cognitive load theory. The model clearly reflects the ideology of the experiential learning theory and constructivism but the cognitive load theory is embedded in flow antecedents. To be more precise, the playability dimension provides some guidelines for reducing the external cognitive load and focused attention dimension in order to impose a germane cognitive load required for schema construction. This combined game-based learning theory is very important because the field of educational technology has lacked a theoretical basis that can be used in designing educational games. This flaw has been primarily expressed in the construction of mostly drill-and-practice games that do not usually support reflective thinking and knowledge construction, which are the aims of the experiential gaming model. The experiential gaming model may contribute to the end of this trend because it helps designers to understand the mechanism of learning with games and integrates pedagogical aspects into design process. Furthermore, this enables a shift from behavioristically oriented games aiming for automatization and training of declarative

knowledge to games emphasizing creative problem-solving, knowledge construction, understanding and adapting of information.

Secondly, the experiential gaming model aims to support the design of flow inducing educational games. The endeavour to design games that enhance experiencing flow is justifiable because previous research (Webster et al., 1993, Ghani, 1991; Skadberg & Kimmel, 2004), as well as the results of this thesis, indicate that flow has a positive impact on learning, exploratory behavior and players' attitudes. The model includes several flow antecedents, validated in this thesis, that should be considered in game design in order to support the flow experience. The antecedents also contributing to captology research are: challenges matched to a player's skill level, clear goals, unambiguous feedback, a sense of control, playability, gamefulness, focused attention, and a frame story used to situate the problems of the game. Design guidelines for these building blocks of flow experience are summarized in Table 4. Flow antecedents do not conflict with a combined game-based theory, but more likely support it. It is important to notice that the flow experience usually occurs when a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile. Supporting the flow experience to lead to states of enjoyment does not require educational gaming to be easy and effortless. On the contrary, educational games should stretch a player's mind to its limits in his effort to overcome worthwhile challenges. This nature of flow supports the premise of using flow as a one design approach in educational game design. However, maybe the most important final result of flow is that flow inducing studying activities are not done with the expectation of some future benefit, but simply because the playing of an educational game itself is the reward. This type of attitude supports the ideology of life-long learning and is priceless goal in education.

Thirdly, the experiential gaming model aims to describe the design process at an abstract level. This description works as a guideline in the design process. The meaning of fast prototyping is emphasized because it provides designers with a fast turn-around for refining the game features implemented, and provides opportunities for end-users to incorporate them in the design process. Additionally, fast prototyping promotes low cost and time efficiency of the design process, as well as enabling use of the games in education during the development process. For example, IT-Emperor was used as the basis of a usability course, although its development was in its initial stages at that time. In spite of that, it was experienced as being an engaging and interesting learning environment. A game world analysis and experience analysis were conducted during the course which enabled the designer to make changes to the game. In the long run, the meaning of the constructed design knowledge base is emphasized. It is obvious that due to the cyclic nature of the design process design knowledge can be re-used productively, not only in the current design project, but also in other projects and contexts promoting low cost and time efficiency. The most important design exemplar produced in this research

was the content creation challenge type that was found to be engaging, effective and cost-saving.

Table 4. Design guidelines for flow antecedents emerging from the results.

Antecedent	Design Guidelines
Challenge	Challenge should match a player's skill level. Level of challenge should be adapted to a player's progression. Game should support skill development and provide rewards from development.
Clear Goals	Game should provide clear main goal at the beginning. Game should provide clear sub-goals at an appropriate pace.
Feedback	Game should provide unambiguous and immediate feedback on a player's actions. Game should provide feedback on progression toward goals. Game should provide feedback on the state of the game.
Focused Attention	Player's attention should not be distracted by irrelevant things. Player's cognitive system should be heavily loaded but within its limits.
Sense of Control	Level of freedom should not be restricted too much. Create at least an illusion that player is in charge in deciding the progress of the game.
Playability	User interface and controls of the game should be easy to use and learn. Provide appropriate tools to achieve goals. Do not overload player's cognitive system with unnecessary sounds and graphics. Animations should be utilized in macro-level structures. Graphics and sounds should be utilized simultaneously. Community formation should be supported.
Frame story	Use frame story to integrate challenges to clear entity and to support perception of goals. Use frame story to situate challenges to meaningful context.
Gamefulness	Gains of the game should be constructive and linked to gameplay events. Provide wide set of challenges in nonlinear way.

In conclusion, although it has been difficult to construct a particular design model for educational games applicable in all situations, the constructed model strengthens the main research objective of this thesis or the assumption underlying it. It was possible to construct a game design model that considers both pedagogical and game design aspects, as well as ways to facilitate the experiences of players. Due to the ill-defined nature of this problem domain, the proposed experiential gaming model describes a general design strategy emphasizing crucial theoretical aspects and practices that should be taken into account in educational game design. In other words, the model provides no simple recipe for designing effective educational games, but it surely provides guidelines for the design of successful ones. Overall, the benefit of experiential gaming model is to develop fast, low budget educational games that are educative while still being engaging and

rewarding. Furthermore, this research also contributes to learning environment design by stressing the importance of facilitating educational experiences of learners. In fact, Article 5 shows one example of how to apply the ideology of experiential gaming model to more traditional learning environments.

#### **8.4.2 Limitations and Directions for Future Research**

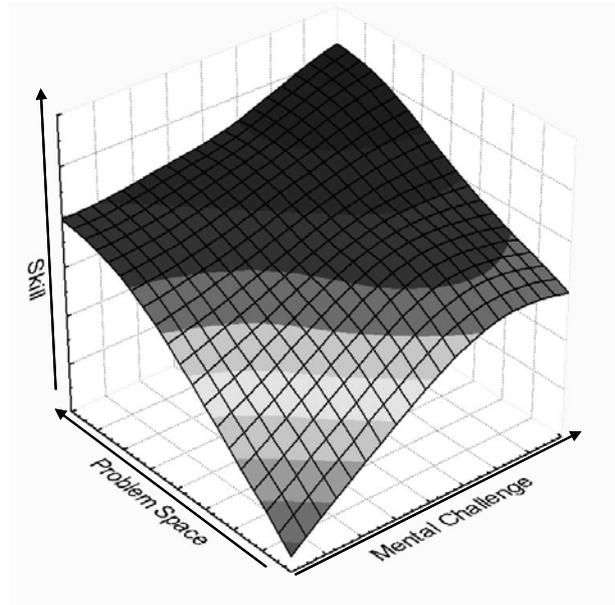
The work reported in this thesis is still in its early stages. The experiential gaming model developed needs to be validated more exhaustively with more complex educational games and greater sample sizes. Especially, gamefulness and focused attention antecedents as well as flow consequences needs to be studied more thoroughly. At the moment, the empirical results gathered cannot be generalized to suit other groups of people except for the fact that the flow antecedents (challenge, goal, feedback, control, and playability) that make experiencing flow possible are independent of gender, age and prior gaming experience as Article 6 (N = 221) indicates. This result is consistent with Csikszentmihalyi's (1991, 49) summarization arguing that optimal experience, and the psychological conditions that make it possible, seem to be the same world over. However, the model still needs further validation starting with studying the experiences of players in the business game called Realgame (Lainema, 2004) that provides an outstanding setting for this purpose. Another point to make is that the experiential gaming model was studied only from the perspective of players, except for the author's experiences on designing IT-Emperor and Day Off games. In order to achieve valid results of the usefulness of an experiential gaming model as a design tool, its use has to be studied with other designers.

It takes time to find suitable research instruments to study flow experience in educational games. In this research virtual observation, interviews, and questionnaires were used to study flow experience. The results of Article 6 demonstrate that both questionnaires used provided satisfactory, useful tools for assessing the flow experiences of players in a game context. However, the interviews conducted in the IT-Emperor case provided much deeper information about the experiences of players than questionnaires, but the interviews were time-consuming. In fast design processes, the importance of questionnaires is emphasized. Thus, the focus of future research will be on testing the usefulness of the Experience Sampling Method (ESM) in a game context. ESM (Csikszentmihalyi, Larson & Prescott, 1997; Csikszentmihalyi & Nakamura, 1989) will be used to continuously gather information about the experiences of players during game playing, rather than after the game session as was done in studies of this thesis. In ESM players are paged throughout the game session for a certain period of time. When paged, players evaluate their activity using a survey instrument. Thus, one future aim is to develop a usable and valid ESM scale for assessing the flow experience of players in educational games. The scales employed in Article 6 work as a departure point in this endeavor. The questionnaire developed will be tested and validated in both Realgame and IT-Emperor settings.

In this research flow experience was studied from an individualistic point of view although IT-Emperor was a collaborative multi-player game. It is obvious that social interactions influence the experiences of players and thus, one future aim is to study the relationship between social context and flow experience.

One challenge, in particular, is to construct the sort of sub models supporting flow experience that can be computationally utilized in game development. In fact, the partners of skill-challenge provide a fruitful framework for designing adaptive systems for games. The challenge of future research is to develop an adaptive Educational Game Model that can be used to describe players, virtual players and contexts within educational games. The three channel model of flow including the zone of proximal development (Article 1) is the departure point of this work, assuming that an optimal development of skills requires controlled change on task challenge. The challenge dimension is not operationalized adequately for this purpose in the original three channel model of flow. Thus the model can not be directly implemented for adaptive educational games.

Figure 26 illustrates the sketch of an adaptive Educational Game Model describing the challenge-skill balance in games. A problem space and mental challenge dimensions together define the challenge -plane to be compared to the skill -plane. The problem space describes the size of the problem and the number of possible paths or answers. The mental challenge describes the complexity of the problem's rules, referring to the intrinsic cognitive load, and the playability of the game referring to extraneous cognitive load. For example, the classical Hanoi towers –task is based on relatively easy rules (low mental challenge), but the task itself has numerous solutions (large problem space). The surface (grayscale in figure) describes the flow –effect in which a user is engaged in the task and development of skills is assumed to be near optimal.



26. Flow surface and development of skills described by factors of problem space and mental challenge.

The model will be utilized in developing adaptive games. The aim of solutions developed is to support a player in achieving and maintaining a flow state by manipulating the challenge level (mental challenge/size of problem space) of the game or by supporting the activity of players in other ways; for example, by generating virtual players to interact with and optimizing the extraneous cognitive load. The main objective of this research will be focused on studying and constructing new ways to observe the challenge-skill balance of players in order to be able to optimize flow experience.

As the results of Article 6 indicated, the outcome of a playing activity did not have clear influence on the perceived challenge level. Accordingly, Ketamo (2002) found out that the amount of right answers in a learning game did not correlate to learning outcomes without also taking into consideration other variables, such as time used to solve the task. In light of these results, adaptation cannot be carried out based only on game achievements. More subtle methods should be considered. Furthermore, the multidimensional skill-challenge balance approach could be a more valid method for adaptation than a game achievement approach. This research will concentrate on studying its effectiveness and usefulness as an adaptation basis.

Another challenge is to study how adaptation can be implemented so that it is transparent to the player to ensure that the player does not change his normal behaviour in the game world. For example, if the player notices that the challenge becomes easier if he performs more poorly than he is capable of performing; the adaptive game engine has failed to provide meaningful challenges to the player. To conclude, the suggestions presented in this section provide many challenges for answering in the future.

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## List of Abbreviations

EGM	Experiential Gaming Model
ESM	Experience Sampling Method
FE	Flow Experience
FSS	Flow State Scale
FS1	Flow Scale 1
FS2	Flow Scale 2
GAM	Game Achievement Model
GBT	Game Based Task
GOM	Game Object Model
HTML	Hyper Text Markup Language, an old W3C specification
IR	Information Retrieval
ISO	International Organization for Standardization
NA	Needs Analysis
PAT	Person-Artifact-Task
POM	Persona Outlining Model
TAM	Technology Acceptance Model
TSL	Teaching-Studying-Learning
XML	eXtensible Markup Language, a W3C specification, <a href="http://www.w3.org/XML">http://www.w3.org/XML</a>
XUL	XML User interface Language
3D	Three Dimensional

## **Appendix 1. The questionnaire for the IT-Emperor study**

The aim of the questionnaire is to study your playing experiences on IT-Emperor. Here, the term playing refers to whole playing experience covering the use of IT-Emperor, creation of components, searching for information, and other game related activities. When you have answered all the questions, press the 'Send Form' button. Thank you!

1. When did you start using Web?  
Under year ago / 1-3 years ago / 3-5 years ago / Over 5 years ago
2. Evaluate, how often do you usually use Web?  
Every day / Almost every day / Once a week / Once in the month
3. I am interested in playing IT-Emperor.  
Agree / Disagree
4. From learning point of view the production of content components was  
very effective / quite effective / quite ineffective / very ineffective
5. I would like to have performed the game part of the course in more traditional way.  
Agree / Disagree
6. Playing the game challenged me to perform to the best of my ability.  
Agree / Disagree
7. Playing the game was challenging.  
Agree / Disagree
8. I did not have to wait feedback too long.  
Agree / Disagree
9. My attention was focused on playing.  
Agree / Disagree
10. I felt in total control of my playing actions.  
Agree / Disagree

11. When playing I felt that I was  
controlling /controlled
12. The usability problems of the game disturbed my playing experience.  
Very much / Some / None
13. Comments about IT-Emperor and your playing experience?

## **Appendix 2. The questionnaire for the multimedia study**

You have 15 minutes time to answer the questions. When you have answered all the questions, press the 'Send Form' button. Thank you!

1. How many blood liters is in adult human being?
2. How can bacteria attack the human organ system?
3. What do bacteria usually do when they have attacked the human organ system?
4. How do white blood cells move in human organ system?
5. Mention two white blood cell types.
6. How different kinds of white blood cells fight against bacteria?

Tampereen teknillinen yliopisto  
PL 527  
33101 Tampere

Tampere University of Technology  
P.O. Box 527  
FIN-33101 Tampere, Finland