G.A.M.E., Games autonomy motivation & education : how autonomy-supportive game design may improve motivation to learn

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G.A.M.E

Games Autonomy Motivation & Education

How autonomy-supportive game design may improve motivation to learn

PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Technische Universiteit Eindhoven, op gezag van de rector magnificus prof.dr.ir. C.J. van Duijn, voor een commissie aangewezen door het College voor Promoties, in het openbaar te verdedigen op donderdag 14 januari 2015 om 16:00 uur

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Menno Deen

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CONTENTS

SUMMARY G.A.M.E

This thesis reviews and utilizes concepts from cognitive psychology, developmental psychology and game design to bring forth a number of design principles for educational games that may improve students' motivation to learn. The main contribution Of this thesis is a novel approach to serious game design, namely envisioning play and learning as a *restructuring practice*. This change of perspective, from a formal game design approach (focused on rules and regulations) towards a more activity centered approach (focused on process and style), may help designers to leverage the motivational potential of games, in order to make education more engaging to students.

The main research question of this thesis is:

> *How to design autonomy-supportive learning games and how can these games improve students' motivation to learn?*

After the introduction, section 2 describes developments in education. Whereas, 'traditional' education focused on the transfer of content and the training of rather specific skills, social constructivist thought in Dutch education brought forward a focus on meta-cognitive skills, such as problem-solving, empathic understanding and entrepreneurship. As a result, Dutch educational system attempts to make students increasingly responsible for their own learning process. One way of doing this is by creating autonomy-supportive learning environments. In these, students have the opportunity to explore, experiment and struggle with the learning content. This manner of learning appears rather playful. Therefore this section concludes that autonomy-supportive learning may proof a valuable approach for serious game designers.

Section 3 stresses the correspondence between autonomy-supportive learning and gameplay. It shows how games have become increasingly autonomy-supportive. For example, players can find multiple solutions to a problem, they can play in accordance to their favored playing styles, and players are increasingly able to self-express themselves through social negotiations with others. Additionally, section 3 introduces the term: *restructuring*. Restructuring suggests the rearrangement and manipulation of existing structures to create something new. It is suggests that play can be characterized as a restructuring practice, and that this may help designers to integrate the learning into the gameplay.

Section 4 suggests that both education and the game industry present their audiences with autonomy-supportive environments. In addition, it suggests that learning and playing can be characterized as a restructuring practice. For example, learners rearrange, manipulate and change existing knowledge actors and structures to construct new knowledge. In comparison, players rearrange, manipulate and change exiting objects, rules, goals and experiences to create something new too.

Play and learning are both considered restructuring practice though social negotiations in a socio-cultural network of human and inhuman actors. Serious game designers can search for the restructureable elements in the learning content and transform them into playful activities. In short, designers could determine what can be changed without changing the learning content and translate this to game mechanics and dynamics. Searching for restructureable elements is considered the main design guideline to integrate the learning into the gameplay.

1

GAMES & MOTIVATION TO LEARN

Section 5 suggests ten designs steps to integrate the learning into the gameplay. Consecutively, Section 6 illustrates the ten steps of embedding the learning content in the gameplay with the development of *Combinatorics* (a game about permutations), followed by Section 7, which combines all insights from development psychology and game design in the Applied Game Design Model. This model describes the ten steps of 'getting the learning into the game'.

The Applied Game Design Model describes the initial concept design of an educational game. Section 8 contributes to this design with various ways to leverage the motivational potential of games. The section starts with explaining the reasons to use Self-Determination Theory as theoretical framework for motivation and consequently suggests various design decisions to satisfy needs for competence, autonomy and relatedness. These design tools are illustrated with the further development of *Combinatorics* in section 9.

Section 10 examined the motivational impact of *Combinatorics*. It describes a comparative study between the experienced regulatory style that was reported by players of an autonomy-supportive version and a restrictive (Drill & Practice) version of *Combinatorics*. Findings suggest that autonomy-supportive games can positively influence motivation towards learning. However, the restrictive version may positively influence motivation to learn as well. It becomes clear that different design decisions lead to different changes in motivation. Future research could study these differences in more detail and over a longer period of time, trying to get a better understanding of restructuring practices and their impact on motivation.

Section 11 discusses the main contributions and positioning of this thesis, followed by the final conclusions in section 12, which revisits the concepts of cognitive psychology, developmental psychology, the Applied Game Design Model and the validation study to suggest a number of design principles for educational games that my improve students' motivation to learn.

SECTION 1 **INTRODUCTION**

In the early 1980's, Nolan Bushnell was selling video game consoles like hot cakes. Parents and children flocked en masse to *Chuck E. Cheese's* restaurants to play arcade hits like *Pong* and *SpaceInvader*. 'More games! More Fun!' the Atari company told customers. Games are fun! Games are engaging!

Children became engrossed in video games. They appeared to lose their sense of time and space while engaging with the new digital medium. Children appeared more attuned to games than showing interest in course books and schoolwork. Consequently, educators tried to engage students into learning by turning learning exercises into games. The combination of entertainment and education was called edutainment.

Atari published many edutainment titles, covering a wide range of educational subjects. Edutainment titles, like *Math Gran Prix* (Atari Inc., 1982) trained learners in a specific set of skills. In *Math Gran Prix* players needed to correctly solve arithmetic formulas within a specific time limit. This added a challenge to the learning exercise. Additionally, a car-race added a fantasy element of Formula 1 to summations. Some scholars suggested that 'challenge' and 'fantasy' were core characteristics that made games so engaging. Despite their findings, recent studies show that the embellishment of educational exercises with game-related fantasies does not increase players' motivation. It appears that there were other elements at play to have children flock en masse to *Chuck E. Cheese*.

This thesis examines the engaging, or motivational elements, that appear embedded in games. Research on the motivational power of games is steadily gaining interest (Felicia, 2011; Habgood, Ainsworth, & Benford, 2005). Most notable is the research within Self-Determination Theory (Ryan, Rigby, & Przybylski, 2006). This cognitive psychologists' theory states that people become highly motivated when three universal human needs are satisfied (Ryan & Deci, 2000). Self-Determination Theory scholars connected the motivational needs to entertainment games and found that some popular games appear to satisfy all universal needs, making them highly engaging.

Figure 1: 80s children playing Mario Bros. in the arcades

In particular, needs for *autonomy* appear well-satisfied by entertainment games. Players can often self-stipulate various routes to a destination. For example, players of the *Grand Theft Auto* series can self-direct their car or player-character to various places in the game. Other games, like *World of Warcaft* offer different characters and/or classes to play with. As a result, players can play in accordance to their favored playing style. Lastly, games like the *Mass Effect* series offer multiple ways to personalize particular aspects of the game. Amongst others, players can change the game's narrative and player-characters' visual appearances. The satisfaction of needs for autonomy in games is dubbed autonomy-supportive game design in this thesis.

The autonomy-support found in entertainment games appears less prominent in edutainment titles. For example, the aforementioned *Math Gran Prix* merely asks players to correctly solve arithmetic formulas. Edutainment games could be more autonomy-supportive. Games that satisfy autonomy may increase motivation to learn. In turn, the increased motivation to learn may benefit learning in general. That is why this thesis examines how to design autonomy-supportive games with an educational purpose, and how autonomy-supportive games may change students' motivation to learn.

The main research question of this thesis is:

How can we design autonomy-supportive games with educational purposes, and how can autonomy-supportive learning games improve students' motivation to learn?

Figure 2: Math Gran Prix: an example of the restrictive nature of edutainment titles of early 80s

Figure 3: Breugel depicted a great variety of playful activities that can be considered autonomy-supportive

1.1   The focus of this thesis

This thesis tries to create a better understanding about the impact and design process of autonomy-supportive games with educational purposes. Combining autonomy-support in games with education may appear adverse to each other. Mostly because play and learning have two different focuses. Play is strongly related to being free; a voluntary and a frivolous diversion (Caillois, 2001); informal acts (Salen & Zimmerman, 2003); and a lack of real consequences (Huizinga, 1951).

In play we enact ourselves, transform objects in creative and new ways, and we feel like autonomous agents, since it is the players themselves who decide. What's more, play offers various ways to self-express oneself (Brock, Dodds, Jarvis, & Olusoga, 2008; Elkind, 2007; M.D & Vaughan, 2009), giving us the ability to explore and develop our identity in various ways (Deen, Schouten, & Bekker, 2011).

These opportunities to engage in self-expression can be intrinsically motivating (Guthrie & Alao, 1997). Being intrinsically motivated suggests that people act autotelic (Csikszentmihalyi, 2002) without an external demand or reward contingencies (Ryan & Deci, 2000). People who are intrinsically motivated engage in an activity because the activity in itself is satisfying to them (Bandura, 1997; Csikszentmihalyi, 2002). To feel intrinsically motivated, it appears that we should be in a place where we can enact our autonomy; in other words, a free space. Schools do not always offer this freedom.

Generally speaking, most teachers embrace a positive attitude towards controlling motivational strategies. The focus upon students' progression and compliance may result in firmly defined learning goals and regulations, such as standardized testing, lesson schedules, and pre-defined curricula. These forms of education are not playful since they are controlling, restrictive, and enforce particular rules that have to be complied with. As a result, opportunities for self-expression and autonomous activity may be diminished and the possibility to become intrinsically motivated to engage in learning may decrease.

As a designer and researcher I had to balance the freedom of open-ended play and the strictnes of formal education. I tried to harness the motivational qualities and creativity associated with open-ended play, and apply those to a game with educational purposes. I tried to understand the design process for games that facilitate learning through play.

The reason to study the design of autonomy-supportive games in a schooling environment is largely inspired by the works of Abt (1971) and Habgood (2007). Both scholars suggest that merely embellishing the learning with game artifacts (as is witnessed in *Math Gran Prix*) is an insufficient means to improve students' motivation towards learning. Habgood suggests stopping the development of 'fantasy themed' learning games. Instead, designers could focus upon transforming the learning into a playful activity. This is what Habgood dubbed the Integrated Design Approach.

Playful learning activities can be designed in various ways. Bogost's (2007) work on procedural rhetoric offers one way to transform learning into a game. Bogost suggests that the intended knowledge construction could be defined as a process. By defining the main procedure of the learning content, the procedure could be transformed into a game. However, the games put forward by Bogost are not very autonomy-supportive. For the larger part, games like *The McDonalds Game* (MolleIndustria, 2006) and *Darfur is Dying* (Ruiz, 2005) have players comply with the values and propositions of the designers. Players seldom have the ability to criticize the designers through gameplay. Players do not have a say. In consequence, they may not feel very autonomous.

Some schools define learning goals and regulations rather firmly. Students need to excel on standardized tests and are supposed to develop very specific skill sets to be honored a degree. Therefore, students' 'say' in their learning is restricted in various ways. Designing for open-ended play in such restrictive environments makes for an ambiguous challenge. The game should offer a particular freedom, but it should also teach the intended knowledge. By developing various serious games, I came up with a design model that builds forth on Habgood's Integrated Design Approach, and that opens up Bogost's Procedural Rhetoric towards autonomy-supportive game design for educational purposes.

To do this, I had to revisit the very nature of play from a designers' perspective. As will become clear, most scholars tend to describe the emotional responses of a playful activity when they define its value. Words like 'free', 'voluntary' and 'informal' are often used to define play. Instead of focusing on the emotional response, I characterized the play as an activity. Section 3.1 explains that defining play as restructuring practice through social negotiations between human and inhuman actors in a socio-cultural network, presents designers with a new way to look at their design process.

Additionally, I studied which motivational elements of games could enrich an autonomy-supportive game, building forth on the work in Self-Determination Theory (Przybylski, Rigby, & Ryan, 2010; Ryan & Deci, 2000). This theory on human motivation suggests that people may become intrinsically motivated if they feel competent, autonomous and related to significant others in relation to the activity at hand.

The scholars brought forth various design decisions to increase students' or players' motivations. Findings of this study were added to the design model; creating a game design guideline for autonomy-supportive games that may improve students' motivation to learn.

In order to validate the hypotheses that a game designed through the Applied Game Design Model would actually improve motivation towards learning, we (Deen & Verhoeven, 2011) developed a game and brought it into a classroom-setting where its motivational impact was measured. The findings of this study suggest the validity of the Applied Game Design Model, and brought forth recommendations for future research and studies.

In order to debate the Applied Game Design Model, this thesis introduces some key aspects of it. Since the model brings together thoughts from education, game design and motivation, the thesis takes turns debating every domain from its respective background. All sections focus particularly on autonomy-support. They build up to the discussion of the Applied Game Design Model, and explain how to get learning into the game (Integrated Design Approach). Additional design guidelines are proposed after debating the theoretical framework on motivation.

The first two sections debate education, followed by Section 3 on game design. Section 4 will connect both domains in order to introduce the Applied Game Design Model. Section 5 builds forth on the previous ones, introducing key aspects of motivation. The section will begin to branch out on thoughts to create autonomy-supportive environments, and how that may effect motivation. Section 6 brings education, game design and motivation together in the second part of the *Applied Game Design Model*. Section 7 presents the findings of a validation study on the motivational impact of an autonomy-supportive game upon learning.
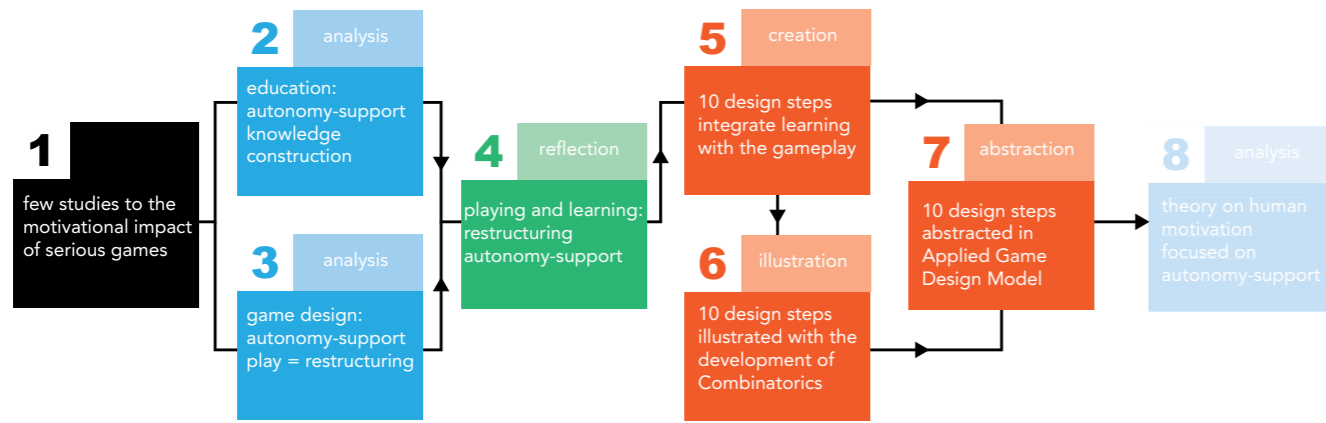
1.2   The structure of this thesis

In order to debate the Applied Game Design Model, this thesis introduces some key aspects of it. Since the model brings together thoughts from education, game design and motivation, the thesis takes turns debating every domain from its respective background. All sections focus particularly on autonomy-support. They build up to the discussion of the Applied Game Design Model, and explain how to get learning into the game (Integrated Design Approach). Additional design guidelines are proposed after debating the theoretical framework on motivation.

Roughly the thesis can be subdivided by two parts that are illustrated in Figure 6: integrating the learning into the gameplay and Figure 7: implementing motivational features. The first part covers section 2 to 7. It describes how education and games can be connected and prescribes a 10-steps-model to integrate the learning with the gameplay. The second part (Figure 7) covers section 8 to 11. It analyzes motivational theories, reflects on them in terms of education and gaming, and creates additional guidelines to implement motivational features in autonomy-supportive games. The next paragraphs explain the section in more depth.

Section 2 presents several challenges in education of autonomy-supportive learning environments. For one, not every student or teacher is accustomed to autonomy-supportive learning. The difficulties arising from this unfamiliarity with autonomy-support can be remedied by gradually pvresenting more freedom and responsibility to students. Other autonomy-supportive didactics are presenting players with meaningful choice on a cognitive level and the development of courses that offer various learning styles.

Section 3 translates the autonomy-supportive didactics of section 2 to a gaming context. Amongst others, autonomy-supportive game design asks designers to abdicate authorship, gradually increase freedom and meaningful choice, and present players with various playing styles. The section introduces a new approach to play definitions: play as a restructuring practice. Restructuring suggests that players manipulate, rearrange or change particular aspects of a game in order to create something new. It is suggest that the more players can restructure, the more autonomous they may feel. It suggests that characterizing gameplay as a restructuring practice could ease the design of autonomy-supportive games, since this play-perspective stimulates approaching play from its main activity instead of starting with (existing) boundaries and regulations.

Section 4 revisits the didactic approaches of section 2 and the game design directions of section 3. It suggests that commonalities between the domains can be found in regarding learning and playing as a restructuring practice. This perspective may help designers to avoid a common pitfall in serious game design, namely, creating a mismatch between knowledge construction and gameplay.

Section 5 elaborates on the way that designers can avoid this pitfall and overcome other challenges presented in section 4. It presents 10 design steps of integrating the learning with the gameplay. This section highly values the input of domain experts and end-users. Domain experts are (groups of) individuals with a thorough understanding of the subject matter at hand. They can be called upon during several stages of concept and prototype development. End-users can perform in play-sessions that serve as user tests. These tests can reveal technical, usability and gameplay issues at early stages of development. The user tests and expert review sessions appear mandatory to integrate the learning processes with the gameplay.

Section 6 illustrates the 10 design steps with the development process of Combinatorics. This case will present a design process of an autonomy-supportive game with educational purposes. It will become clear that the recommendations are not set in stone, but are guidelines to ease the integration of learning with gameplay. With the 10 steps in mind and knowledge about the implementation of the design steps in actual design practice, section 7 presents an overarching model. It serves as a summary of Sections 5 and 6.

Section 2 to 7 explain how 'restructuring' and autonomy-support connects the domain of education with game design. It analyzes the domains to create a theoretical framework on the design of autonomy-supportive games with learning purposes and brings forward 10 practical design steps to integrate the learning with the gameplay. In short, it describes how autonomy-supportive learning games can be designed. However, it remains unclear how they may impact motivation and what additional design steps are necessary to leverage the motivational power of educational games.

That is why section 8 introduces Self-Determination Theory. This is a cognitive psychologist line of research on human motivation, which places high emphasis on autonomous experiences (e.g. enacting self-determined). Self-Determination Theory suggests that motivation can be improved if people feel competent, autonomous and related to others in regard to the activity at hand. Additionally the theory brings forth several regulatory types that can be used to satisfy these three universal human needs.

Section 8 translates five regulatory types to game design decisions and suggests various game design methods to satisfy the three universal human needs (competence, autonomy, and relatedness). As a result, section 8 can be regarded as an extension of the Applied Game Design Model, incorporating motivational features to autonomy-supportive learning games.

Section 9 extends the design directions on motivation, and brings them in context of actual game design. Again, the development of Combinatorics illustrates the design guidelines. The case contextualizes the design for a Zone of Proximal Development, parallel play, gameplay sharing, the use of external and identified regulations, the incorporation of four playing styles, and the application of regulatory fit in the design procedure.

It becomes clear that the design Combinatorics is anchored in theoretical understandings of development psychology, game (design) theory and cognitive psychology on human motivation.

Section 10 validates whether the application of these theoretical constructs have merit in light of improving students'/players' motivation towards learning. This section reports on a validation study to the motivational impact of Combinatorics. It compares two versions of Combinatorics. One is considered autonomy supportive, while the other asks for compliant gameplay (Drill&Practice learning). The game-to-game comparison reveals differences between reported experienced Regulatory Styles toward mathematics education amongst players of Combinatorics.

The validation study suggests that autonomy-supportive games can have a positive impact upon students' motivation. Drill&Practice learning can increase students'' motivation to learn as well. However, the type of motivational impact appears different per game design. The study shows that more in-depth and longitudinal research is needed to create a better understanding about the motivational impact of different design decisions.

The validation study raises questions for future research. Furthermore, it indicates that the autonomy-supportive game design approach makes a contribution to students' motivation to learn. Section 11 elaborates on this and other contributions of the thesis, its position towards academic research and game development, and the section elaborates on thoughts for future research.

Section 12 concludes the thesis by reflecting on all sections. It concludes that perceiving gaming and learning as a restructuring practice may help designers to integrate the learning into the gameplay and how autonomy-supportive learning games may improve students' motivation to learn.

2

EDUCATION:
AUTONOMY-SUPPORTIVE LEARNING

Parts of this section are based on:

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches*. IGI Global.

- Deen, M., & Schouten, B. A. M. (2014). The differences between Problem- Based and Drill & Practice games on motivations to learn. Presented at the International Academic Conference on Meaningful Play, East Lansing.

EDUCATION **AUTONOMY-SUPPORTIVE LEARNING**

Video games have the potential to change the landscape of education as we know it. [...] Video games [may] move our system of education beyond the traditional academic disciplines — derived from medieval scholarship and constituted within schools developed in the Industrial Revolution — and toward a new model of learning through meaningful activity in virtual worlds. And that learning experience will serve as preparation for meaningful activity in our postindustrial, technology-rich, real world. (Shaffer, Squire, Halverson, & Gee, 2005.)

Evangelists Williamson (Shaffer, 2008), Squire (2008), and Gee (2003, 2005, 2008) are renowned for their positive perspective on educational games. The thought that students can engage with systems that are normally difficult to grasp (e.g. economic, ecologic, and political systems), and explore the ideology and epistemology embedded in them by playing with them in a game, inspired teachers and scholars to study the emergent field of serious games for educational purposes.

These scholars make a clear statement: the design of games with educational purposes requires a well-defined perspective on didactics. Preferably a didactic that fits today's changing educational landscape. Or better; today's changing and digitized world. That is what this section is about: Depicting a perspective on didactics that fits today's changing world, and that fits with games. Little will be said about games however; this section solely focuses upon a trend in educational practices where students are presented with increasingly more autonomy.

Squire (2008) states that today's students need to be educated in 'twenty first century' skills. Amongst others, these twenty first century skills concern problem-solving, creative thinking and collaborative learning. This fits the way in which Castells (2002) describes today's socio-cultural world as a networked society. We live in an interconnected world where people from various cultures and disciplines work together in different time schemes and from different locations. Students' should be taught to live in today's world, instead of being taught the skills of the industrial age (Shaffer, 2008).

Figure 8: A traditional classroom

Today's society witnesses an emerging creative class that values conceptual knowledge and original thinking (Singer, Golinkoff, & Hirsh-Pasek, 2006). It appears that working with large amounts of information and qualifying particular sources is valued above (ready) content knowledge and calculating skills. The O4NT.nl project aligns with this reasoning. In September 2013, O4NT.nl opened four schools in the Netherlands.

The schools, dubbed iPadSchools by Dutch news agencies (De Telegraaf, 2013; RTL Nieuws, n.d.), are supposed to prepare children for 'the world of 2030 and later' (O4NT. nl, 2013). Children learn on an iPad. They self-determine when and what to learn. Teachers do not teach in plenary sessions, but are considered coaches. They support students in decision making instead of instructing students in learning historical facts by heart or training in calculation skills.

Amongst others, the iPadSchools were highly criticized by the press. For example: Journalist Derksen (2013) assumes that adolescents are yet incapable of self-determination in their learning process, since they lack training, concentration and focus. Furthermore, Derksen cautions for dereliction of declarative knowledge (vocabulary, grammar and spelling) and for supposedly uninspiring teachers. Additionally, Poorthuis (2013) comments that iPadSchools suffer from a shortage of meaningful social negotiations amongst peers and superiors, because the learning method is too individually oriented.

Most of all, the thought that computers (in this example: iPads) can revolutionize education is received with skepticism. According Kennisnet.nl (2013), this technological deterministic view on ICT in the classroom should be approached carefully and with a didactic approach in mind. This section will explain why social constructivist thought would fit both today's society and the development of Aldrich's 'twenty first century skills'.

Berger & Luckmann's book, *The Social Construction of Reality* (1991), is considered pivotal in the development of social constructivist thought in developmental psychology. Berger & Luckmann suggest that knowledge is derived *from*, and maintained *by* social negotiations. Knowledge, according to social constructivists is in a constant state of flux; it continuously changes. What is considered 'true knowledge' depends on the socio-cultural aspects that influenced the people who constructed this knowledge (Vygotsky, 1978).

Figure 9: iPads are gradually becoming more prominent in school settings

Figure 10:DeCharm's book on personal causation sheds various lights on the subject of self-determination and appeared to be Ryan & Deci's main inspiration

According to Vygotsky (1978) students' knowledge is socio-culturally *constructed*. With the word construction, social constructivists distinguish themselves from other learning theories in how they perceive knowledge development. Social constructivists like Vygotsky agree with Dewey (1910, 1997), that knowledge cannot be transferred from teacher to learner. Instead, people restructure existing knowledge to construct new insights and thoughts. As such, people themselves construct their *own* knowledge and their *own* truths. By interacting with the socio-cultural environment (Bandura, 1997), knowledge and 'truths' are constantly changing. Through this continuous change, knowledge is constructed.

Social Constructivists place high emphasis on students' sense of self-efficacy (Bandura, 1997). Self-efficacy beholds the belief that a student can successfully overcome specific (learning) challenges. It appears important for students to believe that they, themselves, as autonomous individuals, can overcome learning challenges. For example, students' conviction that they can hold their own in a second language conversation, can be attributed to students' belief that they, themselves, are able to use the right vocabulary and grammar to express their thoughts and desires. Students with high self-efficacy in a second language feel able to act autonomously when they go abroad. They can hold their own; they do not need another to overcome the language barrier between them and native speakers.

A learning environment can support this autonomous experience. Being autonomous suggests that the students' locus of causality is internal (DeCharms, 1968). Students with an internal locus of causality are 'in charge' of their own progression. Autonomous students can self-stipulate the way they negotiate with the learning content. Autonomous learners are supposed to be curious, broad-minded, and creative. They can make rapid mental progress, as they tend to focus upon personal growth (Ferriss, 2010, p. 43). In contrast, low autonomy students rely upon others' judgments in decision-making, and easily conform to social pressures. Research shows that students of autonomy-supportive teachers show greater mastery, perceived competence and motivation (Reeve, Jang, Carrell, Jeon, & Barch, 2004, p. 149).

Because of the suggested learning gains in autonomy-supportive learning environments, the iPadSchools present students with digital means (iPads) to self-stipulate their learning process. However, according to the skeptics and the critics, the design of autonomy-supportive learning environments is a process with its shares of obstacles. The difficulties around designing autonomy-supportive learning environments become increasingly clear when one considers all different implementations of social constructivists' thought in education. However, one thread ties all thoughts together: every implementation of social constructivist thought tries to increase students' self-determined behavior, by offering an autonomy-supportive learning environment.

An example of the implementation of social constructive thought is Simons' New Learning Method (Simons, Linden, & Duffy, 2000). The method shifts the focus of teaching practices from the transfer of facts and figures (declarative knowledge), to an understanding of students' learning processes. Teachers ask students questions like: "How did you learn this?", "What was your strategy?" Or, "How would you approach such a problem?" By making the learning process explicit, the New Learning Method educates students in their own learning process; learning to learn is the credo.

A more implicit way of learning is project-based education, as illustrated by van Ernst (2002). Van Ernst shows how a collaborative goal (repairing and selling a wrecked car) in project-based education can foster students' autonomy by offering them an environment in which students can develop the skills they think are of most interest to them (or their future self). In van Ernst's example, students repair a wrecked car. Students adopt a role (e.g. mechanic, salesman, etc.) and learn all the skills that come with the job description. Project-based education, as proposed by van Ernst can create a learning process that is personalized and may fit individual students' desires and talents.

Lastly, Bordewijk's (2009) guide to ICT-education creates a more abstract notion of personalizing education. The guide distinguishes particular 'competencies' that can be developed. These competencies mainly describe meta-cognitive skills, such as professionalism, problem solving skills, and conceptual thinking skills. Students can choose a curriculum that fosters the development of particular meta-cognitive skills. Hereby students are given a degree of ownership over their own learning process and goals.

The sheer amount of different implementations and interpretations of social constructivist thought in education makes for a fuzzy concept. This makes it very hard for designers to work with. However, what all implementations and theoretical frameworks of social constructivist thought have in common is the support of students' autonomy. They all wish to put students in charge of their own learning (enhancing the internal locus of causality) and raise students' self-efficacy in one way or the other.

2.1 Challenges in autonomy-supportive design

As explained above, the design of an autonomy-supportive learning environment comes with its share of obstacles. The aforementioned skepticism surrounding the iPadSchools illustrates popular criticism towards social constructivist thought. Notwithstanding popular criticism, Simon et al.'s (2000) New Learning and Sciarone's Delft's Method (2004) are slowly gaining traction in Dutch education.

This can be witnessed in the implementation of the Second Phase in secondary education, and in the more broadly defined learning goals in Dutch colleges (Bordewijk, 2009; Cluitmans, Bloemen, Oeffelt, & Dekkers, 2009). In these schooling systems, students increasingly have 'a say' and become more responsible for their own learning. This section depicts four major design challenges that designers could consider before attempting the creation of an autonomy-supportive learning environment.

Time
The first challenge is 'time'. Teachers work within specific time-constraints. In The Netherlands, secondary school children ought to finish their education within five to six years, in order to enroll in a university. Additionally Dutch BA and MA students are punished with a fee by the government if their studies take longer than expected. As a result, schools cannot allow students to abbreviate too much from the learning paths laid out. In practices there appears not enough time to learn *when* and *as long* as students prefer. At least, there appears a shortage of time within educational institutions.
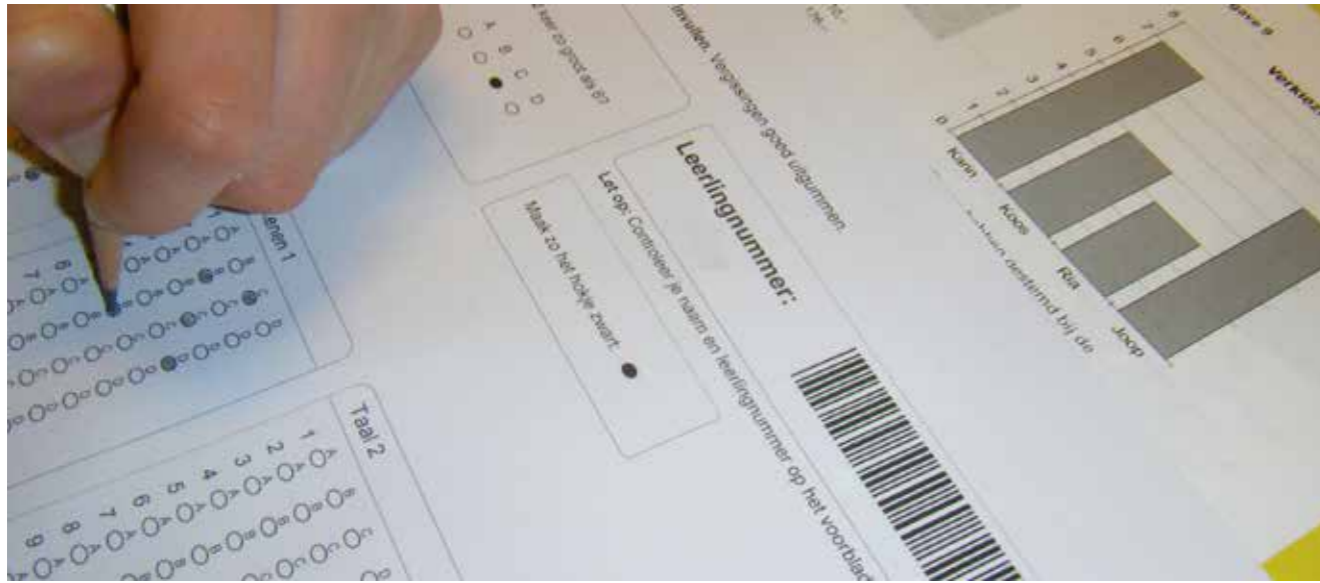
Standardized testing

The second challenge concerns issues with standardized testing. The Dutch government mandates formal and standardized testing to assess the learning outcome of curricula. Standardized testing emphasizes the development of specific skills and memorization of specific facts. This makes for an ambiguous design challenge when one wishes to design an autonomy-supportive learning environment. For one, students are limited in self-stipulating *what* to learn. Instead they ought to develop the skills and knowledge that are considered valuable by our society, instead of self-stipulating what and how students wish to learn.

Diversity

Thirdly, the word 'self' in 'self-legislations', 'self-stipulation', and 'self-determination', and the 'internal' of 'internal causation', suggests a personal experience. Since every person differs from every other, this might imply that teachers need to design for the divergent preference of all students. In an attempt to connect to every individual student's preferences concerning time, content and style, teachers may find themselves designing multiple exercises for one particular skill. The workload of teachers could increase considerably. What's more, the multitude of different exercises may frustrate the aforementioned standardized testing. Since every exercise may focus upon a different skillset, it will be hard to define a generic learning outcome of the curriculum.

Habituation

Lastly, change often deals with habituation issues. In other words, people may not yet be ready for autonomy-supportive learning. In order to have students self-stipulate their own learning process the curriculum should offer students a particular degree of freedom. Since freedom comes with responsibility, teachers have to abdicate the responsibility of learning to the students. This may prove a difficult transition. People may not be accustomed to this responsibility. Educator and philosopher Paulo Reglus Neves Freire discusses the habituation issue of freedom at length in the booklet: *The Pedagogy of the Oppressed* (2000).

Freire (2000) suggests that people who never experienced freedom (and the responsibilities that come with freedom) may have difficulties in understanding what freedom entails. Therefore, they may experience difficulties in presenting freedom to others, and more importantly, they may have difficulties to present freedom to *themselves.*

Figure 13: Primary school students complete a CITO test in their last year to qualify for a particular level of secondary education

Figure 14: Owen Schumacher imitates a Steve Job look-a-like teacher in season 12 of Koefnoen

Freire discusses a surprising act of formerly oppressed people. According to Freire, history has witnessed that the freed tend to copy the behavior of people that they assumed free. Typically, the free people known to formerly oppressed people are their oppressors. People mimic the behavior of the people they assumed free (the oppressors) and start restricting others' lives and freedom. In short, the oppressed become the new oppressors.

According to Rieber (1996), formal educators, who school themselves in social constructivist thought, appear genuinely fearful of existentialism. Existentialism holds the view that any attempt by teachers to make decisions about what students should learn is at best misleading and at worst unethical' (Rieber, 1996, p. 45). The above educators appear to think that radical constructivism is equivalent to instructional chaos. It appears that abdicating responsibility of learning equals abdicating teachers' expertise and authority.

The aforementioned skepticism towards the O4NT.nl initiative exemplifies the fear of existentialism well. The arguments against the initiative (such as no structure, and meaningless social negotiations) are caricatured by the Dutch stand-up comedian Koefnoen (*Koefnoen - Steve Job school*, 2013). In a mocumentary to a StevenJobsSchool, a Jobs look-a-like teacher states that students are completely free in what and how to learn. He explains that his role as a teacher is more that of a (sports) coach.

In response, the interviewer asks skeptically: so you are on the sideline (shouting) and the children do whatever they please? Additionally the teacher is ridiculed by his lack of understanding of iPad usage, the children themselves are better skilled than the teacher. The mocumentary clearly puts popular notions about education, in which children need to be disciplined and in which teachers behold the knowledge, against a fear of existentialism, a loss of authority and expertise amongst teachers.

It is necessary for teachers, designers and learners to grow accustomed to new forms of learning. What's more, designers have to carefully consider where autonomy can be presented. Therefore, the introduction of autonomy-supportive learning needs would benefit from considering the above challenges of *time*, *standardized testing*, the *'self'* and *habituation* issues. The next section describes two ways to (partly) bridge these challenges. The first concerns issues of *where* autonomy can be supported. The second elaborates upon *how* autonomy can be supported.

Which would you prefer?		
Autonomy-supportive		Autonomy-unsupportive
Lost of opperunities	Or	Limited choices
Freedom	Or	Contraints
Make your own decisions	Or	Have others tell you what to do
Do what interests you	Or	Do what you ar told to do
Blaze new trails	Or	Conform to expectations

I have witnessed Freire's declaration, of the oppressed becoming oppressors, at summer camps. During the week, adolescents (aged 15 – 18) spend their time together on a ship. Every day, we go out sailing with smaller boats to return to the ship late in the evening. Participants enjoy much freedom during the week. There are not many rules, except those that concern safety issues on a ship. Participants can largely self-depict what their week looks like. This is especially true for the 'horde-day'. Horde-day is often organized halfway through the week. During the day, staff and participants change roles. Participants become staff-members, and staff-members become participants. Being the new staff, the adolescents are responsible for the day's organization, the program, the sailing-route, buy groceries, etc.

By abdicating our responsibility to participants, participants are presented with a freedom they may have seldom experienced. Instead of showing us the same courtesy, leeway, and freedom we present to them in the previous days, the participants act in a highly hierarchical and oppressive manner. They yell and issue commands to others. This is nothing like the atmosphere of earlier days, where the only rule (other than safety rules) is 'Smear! Don't throw!' during food fights. Many staff members don't enjoy being oppressed by participants, especially since they present participants with as much freedom as they can offer. This is one of the reasons that some staff members do not particularly enjoy the horde-day.

A corresponding experience concerns learning environments. For example, Reeves et al. (2004) argue that despite autonomous students' greater conceptual understanding, higher academic performance, and a greater persistence, most teachers embrace a more positive attitude towards controlling strategies than towards autonomy-supportive strategies. The unwillingness of teachers to embrace autonomy-supportive education may be caused by the assumption that 'enacting our autonomy would entail questioning our values or judgments' (Levinson, 2004, p. 226), or worse, those of our teachers.

2.2 *Where* and *how* to support autonomy

Autonomy-supportive learning environments present students with a particular degree of freedom to choose between various paths to a solution. However, freedom and autonomy do not equal one another. Whereas freedom suggests an experience without rules, boundaries and other constricting elements, autonomy suggests a more constrained experience. Freedom does not equal autonomy; instead freedom is a subset of autonomy.

Rigby & Ryan (2011, p. 39) explore autonomy-support by means of a list of dichotomies (see also Table 1). The left column shows attributes of an environment that supports autonomous experiences. If players are presented with many opportunities and a particular amount of freedom to set their own goals, they may experience a certain intensity of autonomy. In contrast, the right column shows a list of restricting attributes. It suggests that limiting players' choices, and enforcing particular goals and expectations may reduce players' sense of autonomy.

The concept of choice is of interest here. If autonomy-supportive environments offer choice, then some choices can elicit autonomous experiences. Choices that can elicit autonomous experiences are meaningful to students. Learning takes place best when 'children are in environments where learning is occurring in a meaningful context, where they have choices, and where they are encouraged to follow their interests' (Springer, 2008).

In contribution to offering a certain quantity of choice, this section qualifies choice as either meaningful or irrelevant to students. Meaningful choices involve the opportunity for meaningful realization of the individual's desires or preferences (Katz & Assor, 2006, p. 432). It suggests choosing with a 'real' preference, affecting people's interests, volition, goals and values. As a consequence, making a meaningful choice results in the expression of students' interests, volition, goals and values. In short, meaningful choice offers students a way to self-express themselves. In contrast, irrelevant choices do not offer self-expression.

In a learning method called WebQuests (Dodge, 2007), students search the web to find information about a particular subject. They can choose themselves which medium they use to express their findings. This medium typically fits the intended message and the personality of the student. As a result students can self-express themselves through an ownership of form. In this way WebQuests presents students with a meaningful choice that affects students' interests and volition.

Another way of presenting students with meaningful choice concerns ownership of environmental aspects, such as selecting due dates for assignments and choosing a favorite place to work. In Dutch primary education, some schools work with Day/Week Planners. Students are presented with a list of exercises, which should be completed at week's end. Students can self-depict in which order they complete the tasks. Some students may wish to complete particular tasks first, in order to spend the last weekday on their favorite assignment. Other students may carefully balance their days in fun and less enjoyable exercises. The Day/Week planners affect students' goals and values, and in so, offer students a meaningful choice.

According to Stefanou et al. (in Katz & Assor 2006), self-expression through choice can be manifested in three ways: 1) procedurally, 2) organizationally, and 3) cognitively.

1. The **procedural** way encourages students' ownership of form. WebQuests and the Dutch 'Profile Thesis' in secondary education are examples of procedural self-expression.

2. The **organizational** concerns ownership of environmental aspects, Day/Week planners are example of organizational self-expression.

3. The **cognitive** way concerns ownership of the learning process itself. Cognitive autonomy-support asks students to generate their own paths to a solution. This way of meaningful choice will be elaborated upon further in the next sections.

The procedural and organizational forms of presenting students with meaningful choice (e.g. autonomy-support) are well established in today's educational practices. WebQuests contribute to the development of research skills, and the Day/Week Planners help students to develop their planning skills. In the cognitive way, in which students feel ownership over the learning process itself, generating their own path to a solution may seem less obvious. However, one style of learning called Problem-Based Learning appears to do just that.

Bridges & Hallinger (2007) outline the core characteristics of problem-based learning in various steps. One, students start with a problem. This problem is rather loosely defined as something 'for which an individual lacks a ready response' (Hallinger & Bridges, 2007, p. 27). Problem-based education distinguishes between well- and ill-defined problems. Ill-defined, or ill-structured problems are "those that we encounter in everyday life, in which one or several aspects of the situation is not well specified, the goals are unclear, and there is insufficient information to solve them" (Ge & Land, 2004, p. in Ertmer et al., 2008)

A successive step in problem-based learning is that the knowledge that students construct is organized around problems rather than the disciplines (e.g. biology, science, languages etc.). Third, learning occurs within the context of small group discussions rather than lectures. Like project-based education, in which students work in small groups to create a particular artifact, problem-based education poses a problem to be solved by student-groups.

In practice, problem-based education can be illustrated by the course *Swimgames.nl*. Rob Tieben and I developed this course as part of the research programs PlayFit and SixPac. Within these research projects we study ways to elicit physical activity amongst youngsters through playful interventions. We invited students from various disciplines (Industrial Design, Health Care, Software Engineering, Media Design, and Sports) and various levels of education (University, College and Vocational education) to the *National Swimming Centre Tongelreep* in Eindhoven. We confronted students with an ill-defined problem: how to develop a game in a swimming pool for 'a child that is chosen last during gym-classes'? The game should stimulate autonomous play experiences in which physical movement is an integral part of the gameplay.

The problem was ill-defined as it required students to (come to) understand the specifics of a given situation as well as the multiple components of the larger system in which they were embedded (Eseryel, 2006; Xun & Land, 2004). Both the situation (the swimming pool and the children) and the larger system (the research program and the social problem) were unfamiliar to the students. Our students, software engineers, media designers and industrial designers, had never designed for 'casual' sports. The students from other schools and faculties were never part of a (digital) game design process. Students lacked a ready response to the design challenge. This stimulated group discussions about the challenge presented.

We presented students with an ill-defined problem and organized a structure in which students could self-determine how to approach their learning process. Since the ill-defined problem came directly from our own research program, we did not know which end-goals should be met. We could not explain to the students what the game should look like, or which approach towards the problem would be most feasible.

Within problem-based education teachers change their teaching role. Ernest (in Cai, 2007) describes three teaching models:

1. Instructor.

2. Explainer.

3. Facilitator.

Ernest describes how an instructor focuses on the skill mastery and correct performance of the student. Examples of instructing models are learning vocabulary-lists by heart or performing arithmetic calculating exercises. Mastering skills of translating or calculating can concern the repetitive exercise of correctly performing tasks. This educational practice is called Drill & Practice learning and subject to criticism by social constructivists (Dewey, 1997; Vygotsky, 1978) and game-based learning experts Squire (2008) and Prensky (2006).

Critics (Ke & Grabowski, 2007) suggest that students in Drill & Practice learning merely memorize facts. For example, knowing that three times three makes nine, does not prove someone understands why multiplying three units, three times creates nine units. Likewise, remembering that 'On April 1st, Alva lost his glasses'[1] does not account for understanding the significance of the capture of Brielle during the Eighty Years' war between the Low Countries and Spain. It merely teaches that the Spanish Inquisitor lost Brielle on April 1st.

Drill & Practice learning teaches the 'what' and the 'when', but not the 'why' and the 'how'. It may therefore allow less for creative thought or out-of-the-box thinking. In a way, Drill & Practice games make for good laborers of the industrial age (Shaffer, 2008; Shaffer, Squire, Halverson, & Gee, 2005), but not for citizens of today's Networked Society.

The explainer model focuses upon conceptual understanding with unified knowledge. An explainer is typically found presenting lectures. An explainer educates through the transfer of knowledge. This asks for teachers that are highly experienced in the subject they are teaching. Considering the vast changes in today's educational landscape and the growing body of research and knowledge, it may prove an impossible task for teachers to keep up with this continuously growing body of knowledge, and to keep track of changing didactics and new pedagogical insights.

The last teaching model put forward by Ernest is the facilitator. Facilitating learning suggests that teachers present students with the opportunity to *experiment*, *explore* and *struggle* with the learning content to find the 'truth' for themselves (Reeve et al., 2004). An example of facilitating learning is found in Dialogue Education (Vella, 2002). Dialogue Education practices emphasize the conversation between individuals about a particular issue. The learning content is debated and revisited through social negotiations. Educators facilitate the discussion by bringing in content, controversies, and different standpoints. Students debate which point-of-view is of most relevance to them, creating a shared understanding of – and position – in the learning content.

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1   'On April 1st, Alva lost his glasses' is a free translation of a Dutch rhyme that is taught to Dutch students: 'Op 1 april verloor Alva zijn bril' to memorize the Capture of Brielle on April 1st 1572.

Facilitators create autonomy-supportive environments. The relations between facilitators and students can be compared with the relationships between sport-coaches and athletes. Athletes cannot scrip their muscles from other athletes. Nor can they copy muscles from their coach. Instead, athletes have to grow muscle-mass *themselves*. In comparison, students cannot scrip knowledge from their peers. Nor can they copy notes from their tutors and (fully) understand the subject matter. Instead they have to construct their own knowledge.

In this view, athletes and students are responsible for their own progress. Teachers and coaches can help them by creating an environment in which muscles are easily developed. Typically they start with low weights and gradually build up the mass of weights. In comparison, teachers can break down the knowledge into easy to manage content. Considering the teacher as a coach may help designers to abdicate the learning (and not the *expertise* and *authority* of teachers) to students.

Within the aforementioned swimgames.nl course, Tieben and I modeled the teaching role of the facilitator. We facilitated everything that was needed to create games in the swimming pool. Amongst others, we facilitated: access to swimming water twice a week, expert-users, actual users, and knowledge from corresponding domains (health, sports, design, coding).

For the swimming water we had to convince the swimming center to give students free access to explore the boundaries of games in the swimming pool. Safety issues with electricity were taken care of, and we made sure students had at least one power socket to connect a screen. The expert users would be scheduled to give feedback on the first round of prototypes. These users mainly consisted of sports students from college and vocational levels of education. The actual users consisted of children from two nearby schools. They would come in and play the prototypes.

As teachers and researchers, we brought in our knowledge concerning motivation, design process and information about the targeted audience. We were not only facilitating knowledge, but explaining and instructing as well. Taking best of all three teaching models, we presented students with feedback on their design process and depicted the larger time-schedule. We set deadlines and planned access times to the swimming pool. We also questioned design decisions from our perspective on autonomous play experiences and motivational aspects of gameplay.

Figure 20: Mr. Miyagi is best known for his implicit learning strategy (wax on, wax off), however he also coached Daniel to become responsible for his own progress

Figure 21: A scaffold is a safe environment to build knowledge. The scaffold itself serves as a form of progressive feedback, suggesting what is accomplished and what is to come

By acting from our own experience and knowledge we could not only facilitate the right circumstances to learn in, we could also maintain our sense of authority and expertise over both the students and the subject matter at hand. The aforementioned fear of externalism and problems with time constrains were therefore partly remediated. This way, we presented students with ways to learn themselves and become autonomous learners.

2.3 Habituation & the Zone of Proximal Development

The transition to autonomous learning was not an easy task in the swimgames.nl course. This relates to students and teachers. Most of all, the challenges concerned habituation issues. Students were not accustomed to the responsibilities presented. We had to teach them (and ourselves) to understand which learning responsibilities were facilitated by us, and which were the responsibility of students. We had to question ourselves: what to learn, and when to teach? In other words: *when* should we educate, *which* level of autonomy?

According to Wood, Bruner & Ross (1976, in Verenikina, 2003) people learn best when the learning task is not too difficult, and not too easy. The new knowledge is supposed to be a little above students' current knowledge level. The learning difficulty can be raised step-by-step, by breaking the content into manageable pieces that are only a little above students' cognitive level (Verenikina, 2003). This learning principle can be described with $[\,i + 1\,]$, in which i stands for the current knowledge level, and 1 represents the manageable piece of knowledge that is only a little above students' cognitive level.

Wood, Bruner & Ross dubbed this step-by-step educational design *scaffolding*. The metaphor relates to scaffolds used by construction workers. A scaffold is raised for safety reasons and it indicates the size and appearance of the building. The scaffolding metaphor works well to explain the process of step-by-step learning in a safe environment that clearly shows which knowledge will be developed. However, in an environment such as the swimming pool and within the context of a research program, the environment was not familiar (e.g. not safe) and it was unclear what level and kind of knowledge should be developed. For the swimgames.nl course, the scaffolding metaphor appears rather constrictive. As a result, there appears little room for divergence in a scaffolded space.

Vygotsky (1978) partly opens the scaffold metaphor. Vygotsky described the Zone of Proximal Development (ZPD). In essence, scaffolding and ZPD are the same. However the semantics connected with the word 'zone' appear to offer more freedom of choice than the scaffold does. Still, it may offer designers enough handles to work with. The difference between scaffolding and ZPD can be illustrated by comparing the level of design of the game *TokiTori* (Two Tribes B.V., 2011) with *World of Warcraft* (Blizzard Entertainment, 2004).

TokiTori is a puzzle game in which players have to guide a little nestling from point A to B. Every puzzle introduces a new ability or a new and more complex take on the puzzle structure presented. Only when players finish the first level, they can progress to the next. This way, designers can be reasonably sure that the player mastered the former levels. Therefore they can introduce a new puzzle element on top of the former, making the puzzles more complex when players progress through the scaffolded level design.

In comparison, Elwyn Forest in *World of Warcraft* represents a ZPD. Elwyn Forest can be considered level 1 to 10 for Alliance-Human player-characters. Players steer their character through a zone that is populated by foes and friends. The level of a character signifies its strength. For example, Level 1 players are considered weak, especially when fighting higher-level foes. Elwyn Forest is inhabited by level 1 to 10 foes. Players can choose to confront higher-level foes, however the chances of surviving such an encounter can be considered rather limited. As a result, players find themselves quickly fighting foes of their own strength. Therefore, players pick off foes level by level, step by step.

In comparison to *TokiTori*, Players of *World of Warcraft* have significantly more opportunities of choice. Players can ignore the 'level cap' of the zone and wander into higher-level areas such as *Westfall* (level 10-20), *Duskwood* (level 18-30) and *Redridge Mountains* (level 15-25). As long as they keep on the road, players are relatively safe to explore the higher-level zones. However, when confronted with a level 18 wolf in *Duskwood*, a level 1 character will surely not survive. Nonetheless the opportunity to experiment with the boundaries of a character's strength and the opportunity to explore new areas strengthens the autonomous experience in a clearly restricted environment.

Figure 22: World of Warcraft's virtual world is divided in level-capped areas. Feralas is suitable for 35 level characters, whilst only level 55 will survive in Silithus

Figure 23: In the SwimGames course some students developed leadership qualities because we made students gradually more responsible for logistics and planning

In the swimgames.nl course we scaffolded the autonomy-support. In the first week, we (being teachers/coaches) set the stage, demonstrated how to set-up a user test, and organized most of the equipment and design tools. Hereby students could focus on their concept development and experience what a well-planned and prepared test would be like. The second week, students were asked to take responsibility of particular aspects. We 'took our hands off' the organizational aspects, and let them come up with their own approach to user research. Students fail this exercise every year. Since this is the first time that they work with actual users, and since it is the first time they need to organize an actual user test. Therefore, students are ill prepared and show difficulty in improvising when things do not go as planned.

We had to limit student's responsibility in the first two weeks to prepare them for the last two. Due to inactivity in-between play sessions in the first two weeks, users (children aged 8 to 12) were getting bored and cold. Children's teeth were literally chattering from the cold; physically shaking to get warm. That is why we replaced the first two weeks of user testing with two weeks of expert-user review sessions. Being sports students, these expert-users were more accustomed to inactivity in the water, and they could give more valuable feedback to the game developers that incorporated both user-test design issues as gameplay related aspects.

As teachers we tried to intervene less and less every week. Hereby we abdicated the responsibility of a successful user test to the students. Thanks to the opportunity to fail in the second week, students really understood the importance of preparation and co-operation between groups. In the third and fourth week, students acted pro-actively, preparing 'for the worst', and students were able to creatively solve unexpected problems on the fly. The scaffolding of autonomy appeared to work well.

In our experience, autonomy-supportive learning asks for many reflective sessions. After each user test we sat down with students to discuss the user-test. We would reflect on preparations, the distribution of responsibilities amongst the group-members, and lessons learned that considered gameplay, usability and user experience. As said, we carefully scaffolded the responsibility of performing successful user-test and gameplay iterations. The possibility to fail in safe environment (expert-user tests) corresponds to the level 1 character entering *Duskwood*. In this regard, the course aligned to Vygotsky's thoughts on the Zone of Proximal (ZPD) development, since we presented students with the opportunity to fail and self-stipulate what they thought was important.

Scaffolding and the ZPD do not differ in essence. Actually, one could argue that the ZPD consists of many scaffolded paths to choose from. Players can choose their own path to a solution. However, the ZPD offers students to fail and generate their own path to a solution, depending on their competency level. As such, the ZPD elicits more autonomous experiences than a 'simple' scaffold suggests.

2.4 Meaningful choice on a cognitive level: Learning styles

Creating meaningful choice in procedural and organizational aspects appears theoretically easy to accomplish. In practice, the WebQuests and WeekPlanners already show how this can be accomplished. However, students' accomplishments are subject to standardized tests. They are supposed to develop particular skills or competencies within a specific time-period. This places restrictions upon procedural and organizational aspects of presenting students with meaningful choice. The cognitive way appears a feasible solution to present students with meaningful choice in schooling practice.

The cognitive way in presenting students with self-expression through choice concerns the learning *process*. The cognitive way asks students to generate their own paths to a solution. One well-studied way to accomplish this is by incorporating various learning styles in one course.

Learning styles describe the way students learn. Students vary enormously in the manner with which they pick up new information, and the confidence with which they process and use them (Coffield, Moseley, Hall, & Ecclestone, 2004). In the last 40 years, many scholars on human development studied the rich variety in which students approach a learning challenge. It is assumed that knowledge will be constructed faster, and take root better, if the preferred learning styles of students correspond to the style of instruction (Coffield et al., 2004).

Awareness of learning style

Frequently cited and debated are the learning styles of Kolb (Kolb, Boyatzis, & Mainemelis, 2001). Kolb's learning styles are blends of four learning abilities. Kolb differentiates between: concrete experience, abstract conceptualization, reflective observation, and active experimentation. It goes without saying that no individual can be categorized as a pure abstract thinker, or solely focused on concrete experiences. Students merely show an affinity for one particular learning style.

Many studies reviewed by Coffield et.al (2004) focus on students' awareness about their favored learning styles. Concluding from a meta-review of the 13 most influential models, Coffield et al. suggest a consensus amongst scholars that students' motivation to learn increases when students know more about their own strengths and weaknesses (e.g. their learning style).

The focus upon students' awareness may have overshadowed the opportunity for students to *choose* their favored learning style. In many studies, the favored learning style was assessed by means of a questionnaire. The results of the test were presented to students, categorizing them in accordance to Kolb's learning styles. Consequently an exercise that corresponded with the outcome of test was presented to students.

Scholars held the premise that the better the match between students' individual characteristics and instructional components, the more effective or efficient the learning program would be (Katz, 1990). Learning styles can be used to help instructors achieve balanced course instruction and to help students understand their learning strengths and areas for improvement (Felder & Spurlin, 2005, p. 111). However, this premise did not uphold for most studies (Coffield et al., 2004).

Supporting various learning styles

Katz however, presented students with four different learning activities. These four exercises corresponded to Kolb's four learning styles. As such, Katz's study did not enforce learning styles upon students, but offered students the freedom to generate their own path to a solution. This appeared to increase students' higher cognitive reasoning and motivations to learn (Katz 1990 in Coffield et al.).

Silver, Brunsting & Walsh (2007) urge teachers to differentiate their instruction to accommodate to all learning styles. According to Sternbert (2006 in Silver, Brunsting & Walsh, 2007) teaching for diverse styles of learning produces superior results. Apparently the differentiated-instructive approach positively impacts learning. It enables students to capitalize on their strengths, and compensate for their weaknesses by facilitating students to encode material in a variety of ways.

Scholars produced many learning style taxonomies from various perspectives. Amongst others scholars developed the Kolb's Experiential Learning Theory (Kolb et al., 2001), Fleming's (1995) Visual-Aural-Reading-Kinesthtic (VARK) model (Fleming & Baume, 2006) and Silver Strong & Perini's Learning Styles (2000). Taken together, the models present a medley of cognitive activities, external stimuli and physiological forms of learning. For example the VARK model describes the learning styles by external stimuli. VARK distinguishes visual, auditory, kinesthetic and or tactile learners.

Visual learners use their eyes, auditory learners their ears and tactile learners their hands to educate themselves. According to Dunn & Griggs (1995), a learning environment should present students with all the above stimuli to improve learning gain. Hereby, the VARK approach relates to the procedural manner of presenting students with meaningful choice. The VARK approach presents students with ownership over form (procedural way of meaningful choice), since the approach presents students with various external stimuli to choose from (or switch between).

A cognitive way of manifesting meaningful choice can be found in the learning styles described by Silver, Strong & Perini (2000). In line with Katz's findings (in Coffield et. al 2004), Silver, Strong & Perini presented students with exercises that correspond to the learning styles of 1) Mastery, 2) Understanding, 3) Self-Expressive, and 4) Interpersonal oriented students.

1) **Mastery Style** students are sensitive to acts, details, and physical actions. These students have an inclination for remembering facts and figures, to describe their surroundings (often in great detail), and they enjoy manipulating and ordering their surroundings to get a 'hands on experience'. They have a strong ability to organize, report, build, plan and execute projects. In short, Mastery Style students have a rather pragmatic way of learning, which is best utilized through a process of trial and error.
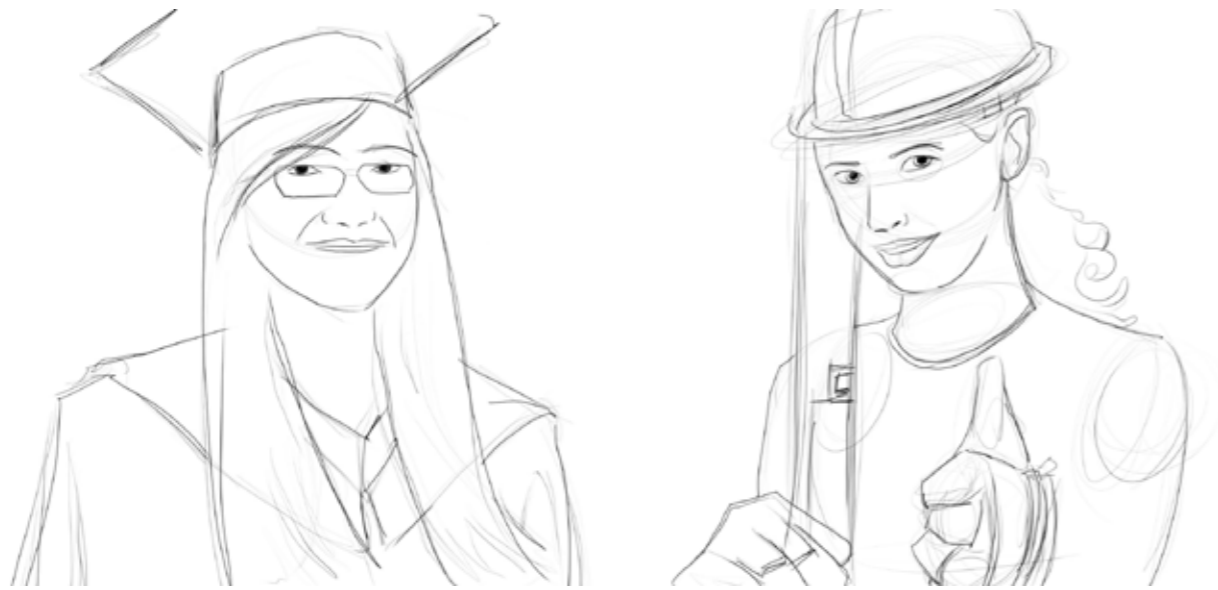
2) **Understanding Style** students are sensitive to gaps and flaws in others' reasoning or theoretical models. They love to answer questions, uncover underlying patterns and new ideas. Their inclination for analyzing, testing or proving, examining and connecting theoretical constructs is best witnessed when they engage in activities such as research and theory development. They possess a keen ability to argue and explain theoretical constructs. In short, these theoretical students enjoy conceptual models and the analyses of complex systems.

3) **Self-Expressive Style** students are sensitive to hunches, images, inspiration and the mere possibility of the new and unexpected. They incline to act from a gut feeling. Their inclination for predicting/speculating about future developments strengthens their interest in generating ideas and developing new insights. Their ability to develop original solutions, think metaphorically, articulate ideas and express and create them is best witnessed in the creative industry. Self-Expressive Style students are creative and imaginative.

4) Lastly, **Interpersonal Style** students are sensitive to their own and other peoples' feelings. Like Self-Expressive learners, they react from their 'gut-feeling' and long for (emotional) experiences. These students express their emotions easily and are therefore rather supportive in peer-to-peer relationships. Interpersonal students have an inclination to personalize their learning environment and activities. Their strong willingness to work with others helps them to learn how to build trust, grow empathy and respond to others' wishes and activities. These social students enjoy project work and can easily take the lead in decision-making and project management.

Offering all four learning styles in one course may prove labor intensive for educators. Silver, Strong & Perini (2000) suggest that teachers create four exercises about the same subject matter. Every exercise corresponds to the aforementioned learning styles. Students can choose which exercises they like best, and learn in accordance to their favored learning style. This asks for a great amount of work, and it differentiates between students as either an Understanding Style oriented student or an Interpersonal Style oriented one.

As mentioned earlier, students can seldom be depicted by one single style orientation. Instead, they can be considered a hybrid of all styles with a dominant preference for one or two particular styles. A more holistic approach towards the incorporating of learning styles would be more feasible in terms of work load and correspondence to students' actual learning preferences. Games may present an opportunity to do just that (see section 3.5).

The assumption that a correspondence between learning style and style of instruction is beneficial to education usurped a large body of research of learning styles. Cognitive developmental psychologists especially appear to be concerned with the way people learn (Felder & Spurlin, 2005; Kolb et al., 2001; Silver et al., 2007, 2000).

According to Katz (in Coffield et al., 2004) and Silver, Strong & Perini (2000) motivations toward learning can be improved if the learning environment supports various learning styles. This way, students have the opportunity to choose *how* they want to learn. According to Katz, this meaningful choice can improve higher cognitive reasoning amongst students. This suggests that the opportunity to choose between various ways of learning may boost both the autonomy, and competence levels of students.

2.5 Facilitating autonomy-supportive learning

New times ask for new education. New education needs new learning methods. Social constructivist thought brings forth innovative approaches that may fit today's changing and networked society. Typically social constructivist learning methods create an autonomy-supportive learning environment. Autonomy-supportive learning environments present students with meaningful choice. This means that students can self-stipulate procedural, organizational and cognitive aspects of the curriculum. Especially the cognitive aspects appear of interest when one wishes to overcome the ambiguous design challenge of autonomy-supportive learning environment that prepare students for standardized testing.

3

AUTONOMY-SUPPORTIVE GAMEPLAY

If students can *generate their own paths to a solution*, students' locus of causality may be perceived as being 'inside themselves'. De Charms' (1968) elaboration on personal causation describes how persons' understanding about their personal interference and influence on their surrounding and behavior can influence motivation. If someone feels 'in charge', the individual's locus of causality is considered high. If someone feels enforced or unable to do something, the individual's locus of causality is considered low. According to Ryan & Deci (2000), a low locus of causality decreases motivation, whilst a high locus of causality may increase motivation to act. The design of autonomy-supportive learning environments may strengthen students' internal locus of causality. As a result, motivation to learn may increase. The sections above discussed how autonomy-supportive learning could be facilitated trough:

1) Meaningful choices that offer self-expression (section 2.2).

2) And, by designing a Zone of Proximal Development (section 2.3).

3) Means to learn in accordance to one's preferred learning styles (section 2.4).

The main premise of autonomy-supportive learning is that it *facilitates* the construction of knowledge. By facilitating learning, students may feel in control of their learning. Hereby, designers abdicate the learning process (not their authority and expertise) to students. This process differs for every student. That is why learning environments can offer various learning styles. Students are therefore presented with meaningful choice on a cognitive level. As a result, they may feel increasingly responsible for their own progress, and motivation to learn may increase.

Parts of this section are based on:

- Deen, M., Heynen, E. J. E., Schouten, B. A. M., van der Helm, G. H. P., & Korebrits, A. M. (2014). Games [4Therapy] Project: Let's talk! Presented at the Games for Health Europe, Utrecht.

- Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven: Leuven University.

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches.* IGI Global.

- Deen, M., Schouten, B., & Bekker, M. M. (Tilde). (2011). Playful Identity. In J. Reasens (Ed.), . Utrecht: Utrecht University.

GAME DESIGN **AUTONOMY-SUPPORTIVE GAMEPLAY**

This section discusses how autonomy-supportive game design can be achieved. One of its main contributions is that it defines play as a restructuring practice and that this approach to play can help designers to create autonomy-supportive games.

"Games are a set of interesting decisions." is what game designer Sid Meier once said. Quoted by Raph Koster (2010), Meier's remark has gained considerable attention, praise, and criticism on the internet. Some think it marginalizes games into a single genre convention (Bateman, 2008), while others suggest that it is an ethos that has served Meier well (Schreier, 2013), hinting to the commercial success of Meier's *Civilization* (MicroProse, 1991) series. Within the scope of this thesis, Meier appears to talk about autonomy-supportive game design.

Meier suggests that these interesting decisions are a set of situations in which the player is constantly confronted with meaningful choices. Meier's meaningful choice is found in the context of the game. Actions taken have 'real' consequences in the game. These consequences can be designed in various ways. For example, Morrison (2013) suggests that meaningful choice require awareness, gameplay consequences, reminders and permanence. According to Morrison, players should be aware that they are making a choice, that this choice has consequences that are both gameplay and aesthetically oriented, that players are reminded of the choice they made, and that players cannot go back and undo their choice after exploring the consequences.

In addition, Meier explains that every game is played in a different way. Every player has a particular way of playing the game. Designing for these different player types can be an interesting approach towards meaningful choice, since the choice may resonate with players' personalities. Game Designer VandeBerghe (2012) consulted the audience at the annual Game Developers' Conference in San Francisco on how to design with particular psychological types in mind. VandeBerghe suggests that meaningful choice can be designed by looking at players (instead of the context of the game).

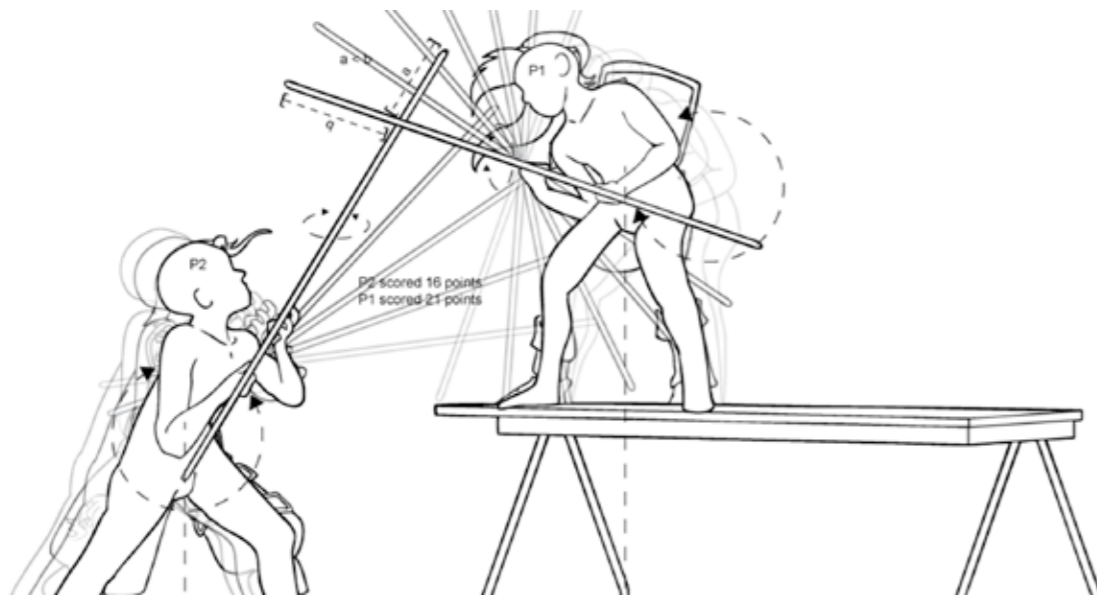*Figure 26: Screenshot of Civilization*

The approach of designing meaningful choice in this thesis aligns with the above suggestions: Players are able to see their actions reflected in the game, and the games can support a rich variety of ways to play. This idea to design for meaningful choice further aligns with the previous section of meaningful choice in autonomy-supportive learning environments. In these learning environments, students are in charge of, and responsible for, their own learning. Amongst others, meaningful choice in learning environments can be found in the self-expression of students through means of knowledge construction.

In comparison, autonomy-supportive games empower players to create and make them responsible for their own playful experience. Meaningful choice can be found in the self-expression of players though the means of play. As a result, players may feel that their decisions influence the game. In the words of DeCharms (1968): If people feel as though they are autonomous agents, their locus of causality is internal.

This thesis brings forth three design guidelines for autonomy-supportive games that may present players with meaningful choice. In order of appearance they are: 1) Considering gameplay as a restructuring practice (Design from the Dynamics), 2) Abdicating authorship (Gradually increase autonomy-support), and 3) Design for various playing styles.

Considering gameplay as a restructuring practice
Gameplay can be considered a restructuring practice. This suggests that gameplay is by definition a process in which players rearrange, manipulate or change an existing configuration to create something new. This restructuring is persistent in all forms of gameplay. Recognizing this may help designers to recognize restructureable elements in learning content or in everyday life, and consequently transform them into interesting gameplay. Additionally, it may contribute to the design from the dynamics approach discussed in section 3.2.

The design from the dynamics approach contributes to Hunicke, LeBlanc & Zubek's (2004) MDA model. Hunicke et.al. suggest that games concern mechanics (the rules and regulations that make up the game), dynamics (the playful behavior that emerges from interaction with the mechanics) and aesthetics (the emotional experiences resonating from the gameplay).

At a workshop at the Game Developers Conference in 2011, LeBlanc suggested that games are typically designed by using the mechanics (rules) as initial concept. He suggested that games can also be designed by starting with the aesthetics (experience). This thesis suggests that designing from the game's dynamics may prove a fruitful approach when designing autonomy-supportive environments. This is basically because designers start with a playful activity that is less restricted by rules or pre-defined experiences.

Abdicating authorship
The above approach; taking existing playful activities (e.g. restructuring activities) as an initial concept for game design, can change the traditional role of the designer. Like the teachers in section 2.2, game designers can gradually abdicate their authorship upon the rules and boundaries of the game to players. As a result players can become increasingly responsible for their own gameplay, heightening their internal locus of causality and autonomy-support of the game.

Players and designers may not yet be accustomed to high degrees of autonomy-support in games. It is therefore suggested that the designer gradually present players with more autonomy. This 'scaffolding '(see section 2.3) of autonomy-support suggests that players can increasingly generate their own path while their ability to do so grows. Section 3.4 discusses how designers (can) design for this habituation process.

Design for various playing styles
Lastly, in contribution to Meier's (2012) suggestion for the design for various playing types, and Vandenberghe's (2012) plea to incorporate the Big Five of personality types in game design, this thesis suggests that games can become increasingly more autonomy-supportive if they incorporate four playing styles. These playing styles are strikingly similar to the learning styles of section 2.4. It will become clear how various playing styles can easily be implemented in game design.
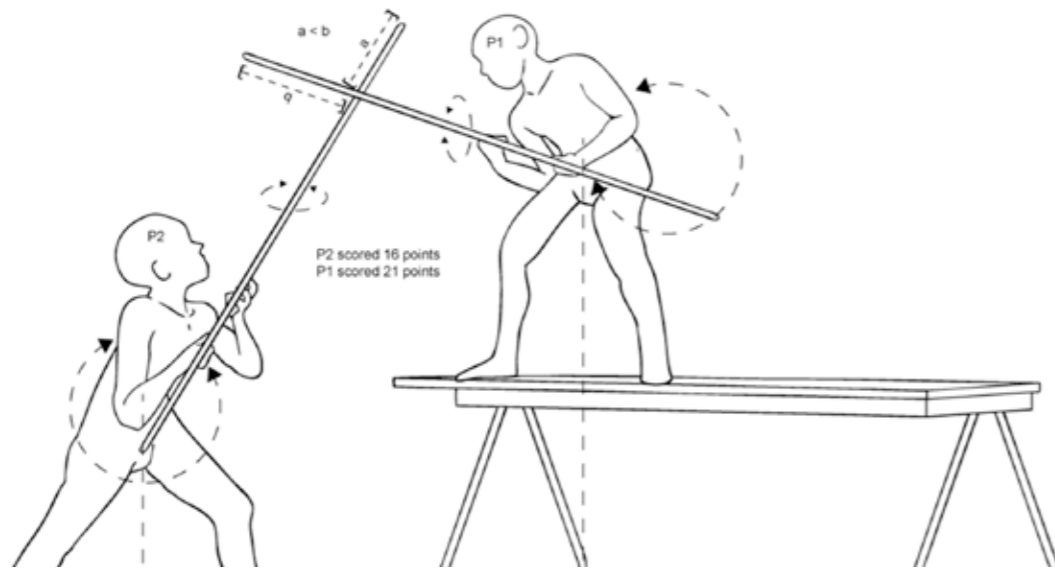
3.1 Gameplay as restructuring practice

In order to understand why a design practice from dynamics is important, and why regarding gameplay as a restructuring practice may help designers to create autonomy-supportive games, this section positions 'gameplay as restructuring practice'

This thesis differentiates four main categories or game definitions. In order of appearances the next four categories are discussed:

1. **Formal** definitions: Games as artifact. This section deals with games as an object with solid boundaries and clearly defined goals. Formal definitions tend to describe games as an artifact; a solid state of being.

2. **Socio-cognitive** definitions: Games as experience. This section deals with games as a performative experience. The designers aligning with this definition appear to create games that rely heavily upon narrative and/or (hedonistic) experiences.

3. **Holistic** definitions: Games as framework. This section deals with definitions that attempt to capture the whole game experience in one definition.

4. **Activity** definitions: Games as process. This section takes the above definitions in regard but focuses mainly on games (and more precisely on gameplay) as a process.

The characterizing gameplay was mandated by a search for autonomy-supportive game design guidelines. If designers wish to design for a particular freedom, meaningful choice and self-expression, it may prove difficult to start with boundaries (formal definitions), predetermined decision trees (socio-cognitive definitions), or strongly authored designs (holistic definitions). Instead it would be interesting to explore how to start a game design with the play-activity as an initial concept, and create an environment that facilitates this form of play (instead of enforcing it). In order to do so, it may prove necessary to characterize this play-activity to guide the design process towards autonomy-supportive games.

Figure 28: Mechanics

Figure 29: The amount of different species of Pokémon is 721 and counting

Formal definitions: Games as artifact

Formal game definition focuses on games as a system, and not on the relations between games and players (Dormans, 2012, p. 5). For example, Salen & Zimmerman (2003) define games as artificial conflict, based on rules with a quantifiable outcome. Here the formal definition clearly describes the confines in which play takes place. From a designers' perspective, the definition clearly confines the design boundaries in a productive manner, since it presents designers with clear handles to design from.

Formal definitions mainly describe the components of a game at the level of data representation and algorithms. This is what Hunicke, LeBlanck & Zubek (2004) dubbed the Mechanics. In Figure 28 two children mimic a *SoulCalibur* fight. The image presents the physical parameters (size, weight, height, possible angles, etc.) of the wooden sticks, the children and the table. All these components, rules and objectives constitute the game's mechanics.

Mechanics include socially constructed rules as well. These rules are less embedded in the artifacts (i.e. the physical parameters) but are found in relation between players, designers and the artifact itself. A socially constructed rule could be: One hit is worth two points, and hitting your opponent's head is worth four. Digital games tend to incorporate these kinds of rules in the artifact itself.

Designers can create a game by starting with the mechanics. By doing so, one could state that designers adhere to formal definitions of games. The design from mechanics approach is best witnessed in game sequels. The *Pokémon* (Game Freak, 1996) series can illustrate a game design that starts with existing mechanics and iterate every new release upon these rules to enrich the game. *Pokémon* players collect multiple pocket-monsters (pokémon) by battling them in turn-based fights. The battle mechanics of *Pokémon* correspond to a rock-paper-scissor formation.

The rock-paper-scissors formation is a design pattern, in which sets 'of three or more actions form cycles where every action has an advantage over another action' (Björk & Holopainen, 2004). In *Pokémon*, grass-type pokémon have an advantage over water-type. Consequently, water-types have an advantage over fire, which close the circle with an advantage over grass-type pokémon. Players are invited to create a balanced team of pokémon in order to progress through the game.
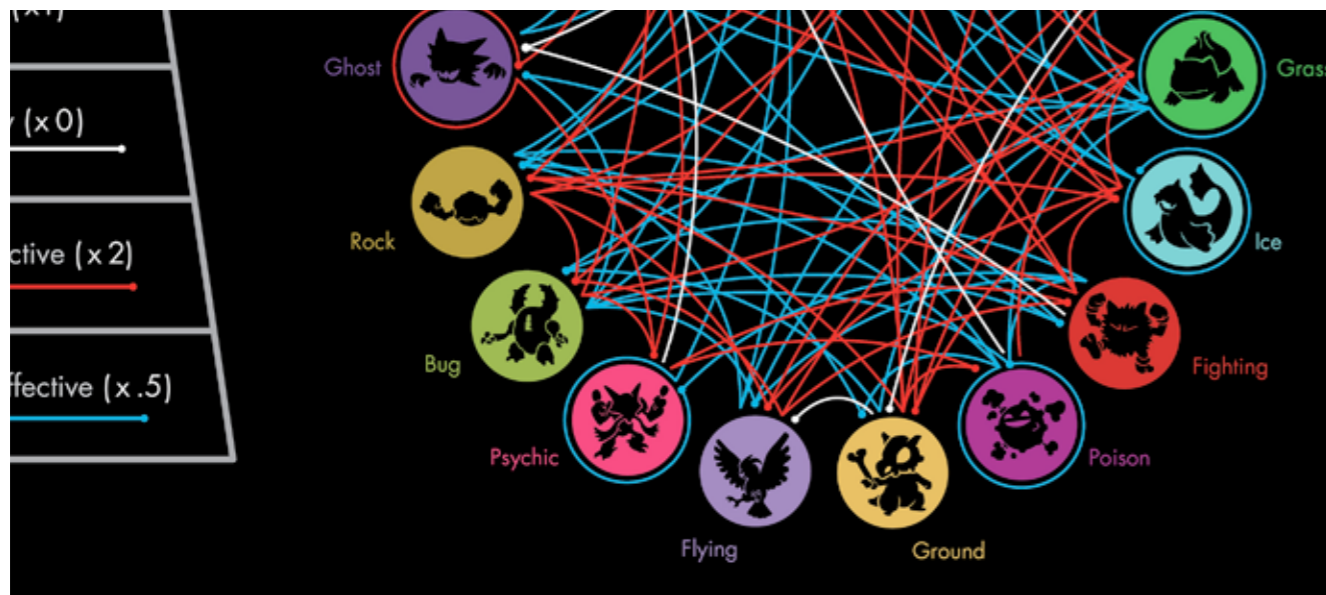
Pokémon's huge success in sales (said to be partly responsible for enlivening the Gameboy as a game platform) resulted in many sequels of the original game. Starting with 151 different species and 15 types of pokémon, the sixth generation of the series continued to build towards 721 species (+19 mega evolutions of specific pokémon) and 18 types. As a result, the mechanics of *Pokémon* as a game are incredibly complex, especially taking double typed pokémon into regard. Figure 30 shows the complexity of *Pokémon's* main mechanics. Building forth on these mechanics by adding numbers and complexity is often witnessed in game sequels, where designers iterate upon existing mechanics to create new dynamics and aesthetics.

Defining games as an artificial conflict, based on rules with a quantifiable outcome mainly describes the games' mechanics. It describes the games' pre-defined rule-set and boundaries, hence, it starts with restrictions, which may frustrate the design of autonomy-supportive games that are strongly associated with a sense of freedom.

Socio-cognitive definitions: Games as experience

The second category of definitions concerns the relationship between games and players. It is therefore dubbed socio-cognitive, since it describes the socio-cultural values that are appointed to games and the mental experiences that appear strongly associated to gameplay. The work of Caillois (2001) can be categorized as a socio-cognitive definition. Caillois distinguishes play (paidea) from gaming (ludus).

Paidea is related to experiences such that are active, tumultuous, exuberant and spontaneous. Climbing a tree, for example, is an active undertaking, which is a reasonably spontaneous activity. Children seldom make elaborate planning schemes before climbing a tree. Instead children will exuberantly climb the tree. When they reach a high spot or when they are scared to come down they probably shout excitingly. Since tree climbing can be associated to tumultuous, exuberant and spontaneous experiences, it can be considered paidea.
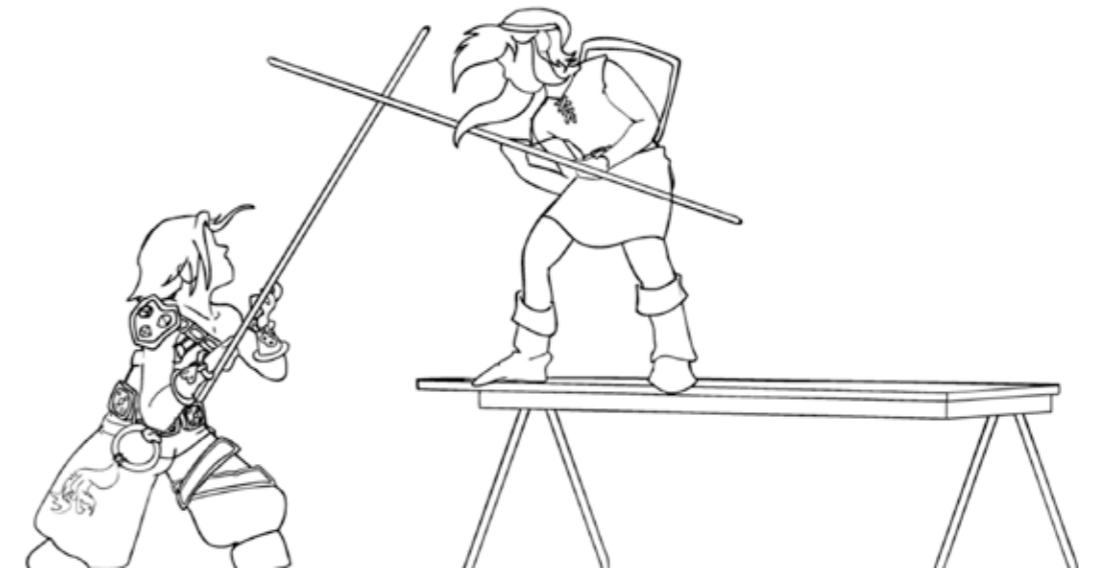
In comparison, ludus represent calculation, contrivance and subordination to rules. It describes how people formalize play (i.e. paidea). In relation to the aforementioned tree climbing, the paidea becomes ludus when players try to reach the highest end of the tree as fast as possible. The children may declare the fastest climber the winner of the game, hereby formalizing paidea into ludus. This formalizing of play is implemented in rock climbing and to further extends in sport climbing. In sport climbing, anchors are fixed on the rock to create interesting routes and various level of difficulties in climbing.

Sport climbers enforce themselves to obey to particular rules (e.g. only use blue anchors and bolts to climb) in order to elicit particular experience or give a subjective meaning to the activity. This formalization of play can elicit highly satisfying experiences of accomplishments, thrill and pride.

Since Caillois, many other scholars have connected socio-cognitive experiences to games. For example the Playful Experience Framework (PLEX) by Korhonen, Montola, & Arrasvuori (2009) presents various game-related experiences. Amongst others, PLEX describes the experiences such as: completion, discovery, exploration, expression, nurture, submission and sympathy. These emotional responses are dubbed Aesthetics by Hunicke, LeBlanc & Zubek (2004). At the Game Design Workshop on the Game Developers Conference in San Francisco, LeBlanc suggested that games design could be initiated from the Aesthetics as well.

The aesthetics describe the emotional responses and visual appearances of a game[1]. If the stick fighting children are dressed up like Kilik (from *SoulCalibur* series) and Link (from *Legend of Zelda* series), the resemblance to game-heroes constitute as the aesthetics of the game (see Figure 31). Also, the feeling of empowerment, the joy of winning, the embarrassment of being hit, and the pain accompanying a hit, are all part of the game's aesthetics.

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1   The MDA-Model states that visual representations belong to the mechanics. Representations express the rules and partly steer the dynamics and aesthetics of the game. However, dressing-up as Link and wielding a stick appears more connected to the expression of the player than the representation of rules. That is why a slight change in interpreting the MDA model is made.
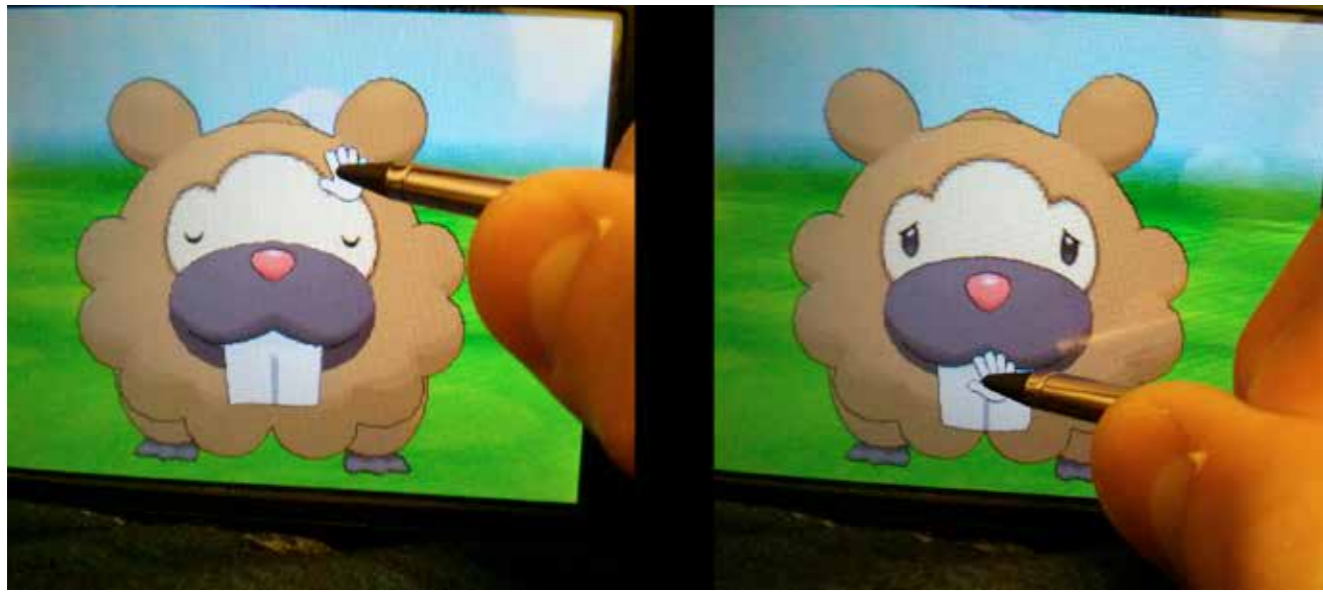
Another example is the nurturing experience that *Pokémon* appears to stimulate, especially in its latest installment *Pokémon X & Y* (Game Freak, 2013). This game introduces players to Pokémon-Amie, wherein players can poke, stroke and feed their pokémon. As a result, the pokémon will grow more attached to the trainer, which makes it stronger in battle. The caring behavior of stroking and feeding pets, and its connection to pokémon battle stats, may enhance the nurturing experience.

For some pokémon, the nurturing behavior even affects the pokémon's attire. The pokémon called Furfrou will change its appearances in accordance to the attention given to it. Furfrou is poodle like pokémon. Its fur can be trimmed, but will grow back in five days, enforcing the nurturing behavior upon players and punishing them for not complying to the rule set that is pre-defined by the designer.

The design from the aesthetics can result in new and innovative gameplay. What's more, it can add a layer of value to mere digits. Pokémon, of course, is in essence merely a set of data, which players can change through putting significant effort in it. However, the design from aesthetics approach can have designers focus on eliciting very particular experiences. As a result, designers may enforce players to play in a certain manner. Therefore, the design with a particular aesthetic as initial concept may hinder the development of autonomy-supportive games.

Defining games by its associated socio-cognitive experience, mainly describes the games' aesthetics. It describes the emotional response that would most probably emerge from gameplay. Hence, it starts with restrictions, which may frustrate the design of autonomy-supportive games that are strongly associated with a sense of freedom.

In the Design from Aesthetics approach, designers take a particular experience as design goal. For example, it is safe to assume that a fearsome experience was the design goal for *Resident Evil* (Capcom, 1996). The puzzle-horror game is designed to create suspense and elicit feelings of entrapment. Amongst others, Capcom purposefully restricted specific camera movements to create a feeling of suspense. As a result, the view angle of players is limited, making it easier to hide foes and suggest that there is something 'lurking in the dark' or 'in the corner of your eye'.
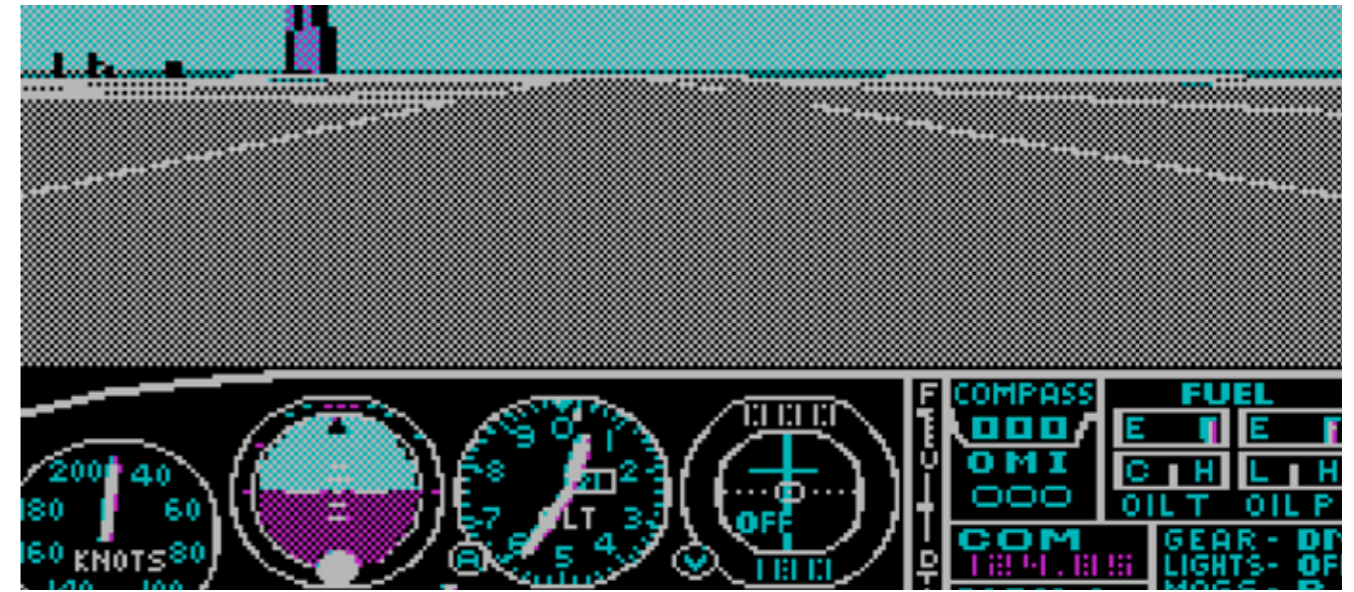
Holistic definitions: Games as framework

The third category of definitions concerns a hybrid approach. It regards games as artifact and incorporates the socio-cognitive experiences associated to gameplay. Hybrid definitions build a framework of rules and experiences that constitute a game. They try to incorporate all the aspects of a game. Therefore, these hybrid approaches can be considered holistic definitions.

For example, Juul (2005) defines games as "A rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable." (2005, p. 36.) Therefore the game becomes a continuously changing entity that is subject to the social negotiations taking place in and around it. The game is therefore both formal and informal, its outcome valuable and invaluable, and its consequence un-predefined.

Juul's thoughts appear to align with Sutton-Smith's (1997) approach towards gaming/ play as an ambiguous process. Sutton-Smith taps upon the experience and the formal aspects of gameplay. Play can be restricted and free, frivolous and serious, and thus an ambiguous experience. In line with Sutton-Smith's reasoning, game designer and researcher Gonzalo Frasca (2001) suggests that games can be both ludus and paidea, and that players themselves are able to switch between the two experiences at will.

For example, players of *Microsoft Flight Simulator* (subLOGIC, 1982) and *Pilotwings Resort* (Monster Games, 2011) can fly around aimlessly, without a goal in mind. This play behavior suggests a paidea experience. However, players can also impose a ludus rule upon themselves. Amongst others, players can perform a particular maneuver without crashing. As a result, players self-impose rules on their paidea experience, turning it into a a ludus experience.

Frasca states that "It is the player, and not the designer, who decides how to use a toy, a game, or a videogame. The designer might suggest a set of rules, but the player always has the final decision." (2001: 13-4.) It appears that Frasca suggests an autonomy-supportive game in which players can self-determine how to play.

In contribution, Rouse & Ogden (2010) suggest that game designers can provide a framework, tools and space with which players can work (e.g. play). Thereby, echoing Church's design goal of "A carefully authored environment [that] can abdicate the specific control to the player, who can then make and fulfill their own plans and decisions."(Meadows, 2002.)

Games with holistic definitions provide players with a framework to play with. The framework-design approach is witnessed in games such as *The Sims* (Maxis, 2000) and *The Great Flu* (Ranj Serious Games, 2009). Players of these games explore a complex system of formal rules and socio-cultural regulations. Players of *The Sims* can keep their characters alive and prosper in a caricature of the American lifestyle. Since the game does not end when a character dies, players discovered ways to starve characters by enclosing them in rooms without doors.

In comparison, *The Great Flu* has a pre-defined goal. In this game, players try to prevent a pandemic by managing particular resources that may hold off the spread of a flu virus. The game confronts players with ways to control the outbreak. Instead of saving people, players can try to do the opposite: create a pandemic as fast as possible, trying to infect the whole world.

The framework approach appears to result in simulation games. These games present players with a particular perspective on complex issues. For example, *The Great Flu* presents a particular perspective on preventing a pandemic. This perspective is largely based on medical research, which is probably due to the collaboration between *Ranj Serious Games* and the *Erasmus University of Rotterdam* faculty of Health. Due to the medical perspective, players will learn to think as a medic while preventing a pandemic.

For example, players can choose to distribute face masks, isolate symptomatic individuals, stockpile vaccines or invest in specialized research. If, on the other hand, *Ranj* had (let's surmise) the Dutch government as a client, it would probably have favored politics above medicine. In that imaginary game, players would choose to lobby with neighboring governments, close boarders to immigrants, increase tax to support research, and create awareness. It would likely have adhered to the perspective of a politician.

The different perspectives on work, systems and life can be called epistemic frames. An epistemic frame describes the way we look at things or the way we approach challenges. Shaffer (2008) elaborates how epistemic frames can be used as initial concept for a game. Designers can create an environment in which players need to adopt a particular perspective that corresponds to the epistemic frame of a professional. For example, in a game about urban planning, players can take on the role of a construction worker or that of a government representative. Like the example of *The Great Flu*, this will lead to completely different mechanics, since the game is designed with a particular epistemology (construction worker vs. politician) in mind.

In epistemic games, players take on a particular role in the simulation-like game. These roles correspond with the roles of professionals in similar situations. Therefore epistemic games "Are rich contexts for learning because they make it possible for players to experiment with new and powerful identities." (Shaffer et al., 2005, p. 106.) Players 'literally' have to fill someone else's shoes as they are forced to make decisions from a particular perspective. "An epistemic game 'requires you to think in a particular way about the world." (Shaffer, 2008.)

According to Schaffer (2008), *The Debating Game* is an epistemic game. In this role-playing game, players take roles in a debate. They are asked to defend a political position. In short time frames players bombard the opposing party with arguments to strengthen their position. In the end, the public decides who wins the debate. The teachers (or game designers) merely set the stage for the play. The players do the rest.

By actively negotiating with the rules and regulations of the simulation, players create a better understanding of their adopted role. As a result, the games make it possible to 'learn by doing' (Shaffer et al., 2005, p. 108). However, Shaffer does not characterize this 'doing', nor do formal and socio-cognitive definitions characterize the activity of play. The next section will show how the characterization of play as a restructuring process may help designers to develop autonomy-supportive games. Additionally it adds a fourth category to the above categories of game definitions, namely a definition that is derived from the activity: Games as a process.
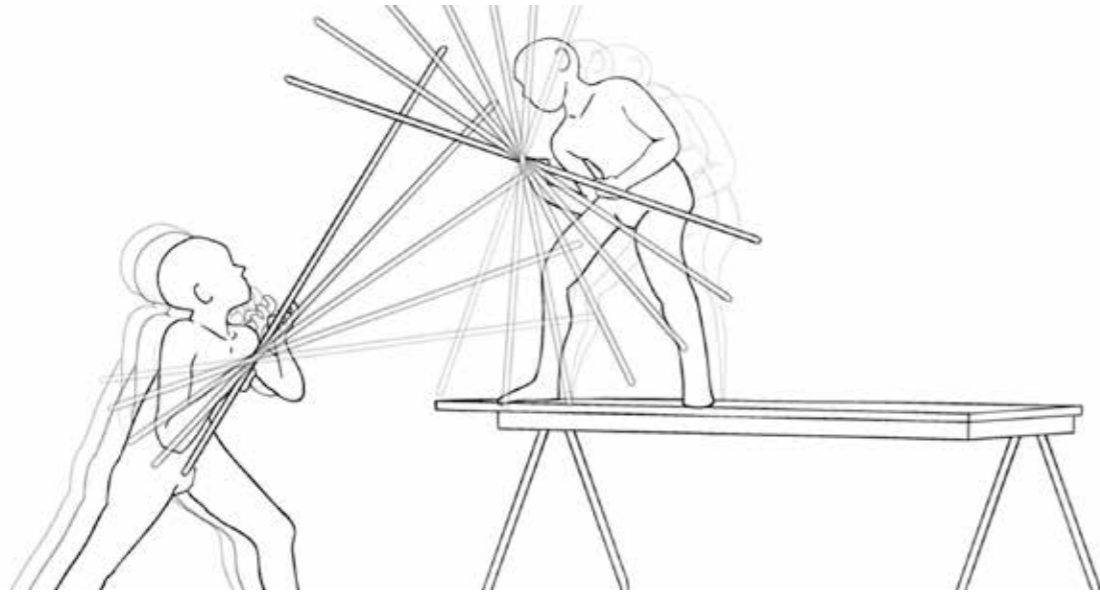
Activity defined: Games as a process

Games are defined by their mechanics, their aesthetics, and/or by both. Subsequently, this may have resulted in formal, socio-cognitive, and holistic definitions. This section focuses less on the mechanics and characterizes the dynamics of games that stimulate autonomous experiences. The dynamics describe the playful activity. They are the actual performance of play. In the example of the two children fighting with bo-staffs, the dynamics can described the wielding of bo-staffs into various positions, the emergence of strategies to trick an opponent, or the rearrangement of environmental objects (i.e. the table to take advantage of heights (see Figure 36).

It may prove fruitful for autonomy-supportive game design to take the dynamics as the initial concept. By focusing less on the mechanics and more on play, designers may feel less restricted by the design of rules and boundaries. Instead they can try to facilitate a particular activity. This section will explain how designers can design from the dynamics. In order to do so, it is necessary to characterize the dynamics in such a way that they can be of use to designers.

Copier (2007) characterizes dynamics as a social negotiation. According to Copier (2005), games only exist when they are played. When players play the game they negotiate with the game's rules to see what they can, and what they cannot, do. Since games are always developed and played by people, this negotiation is strongly socially authored and appears to occur between social actors. The characterization of the negotiation should therefore be found in the acts performed by players. How players act differentiates every negotiation. It is in this continuous change that the characteristic of play can be found.

Developmental psychologists Jarvis, Brock & Brown (2008) describe how play emphasizes the restructuring, enriching and discovering of the environments and mental exercises (e.g. imagination, problem solving ability, closure). Play builds upon personal experiences and knowledge and creates new activities and meaning. The word that characterizes an activity performed by people is 'restructuring'.

Restructuring suggests the rearrangement, manipulation and changing of existing configurations to construct something new. It is the manipulation and rearrangement of the game's objects, rules, goals and environments that constitutes gameplay. Play is manipulation (Schell, 2008, p. 37). This restructuring is always (even in single player games) embedded in a socio-cultural network, wherein players negotiate with other individuals.

Gameplay is a restructuring practice (Deen & Schouten, 2010); players continuously negotiate with the system, other players, and the designers. Through these social negotiations gameplay is in a constant state of flux; it is a unique experience and activity.

This definition of gameplay brings forward a focus upon the game as a process. It takes the continuous change that appears so inherent to a playful activity into account. Hereby it may open up formal game definitions, and definitions focused upon socio-cognitive experiences, to become less restrictive and more open to players to change and alter specific elements. This thesis contributes to holistic definitions and presents a design direction that starts from the dynamics.

It will become clear that defining gameplay as a restructuring practice can shift the focus of game design and research. Whereas formal definitions focus upon the game-artifact (rules, goals, environments etc.), the restructuring approach focuses upon the play *activity*, on the gameplay. In other words, formal definitions focus upon the actors, the restructuring approach focuses upon the (changing) relationships between actors. As a result, design approaches can shift towards designing from the activities that constitute as gameplay (i.e. restructuring practices).

3.2 Design from the dynamics

Autonomy-supportive games suggest that players have the opportunity to explore, experiment and struggle with game's mechanics to create a personal style of play, maybe even set personal goals or change the game's rules to their liking. As a result, designers should abdicate parts of their authorship on the mechanics, dynamics and aesthetics to players. It remains unclear however, how this can be accomplished. In order to create a better understanding of this process, we brought students of Fontys Information & Communication Technology and the Eindhoven University of Technology to the swimming pool and asked them to create autonomy-supportive games for recreational swimmers.

The swim game needed to increase physical (swimming) activity amongst youngsters, but should offer room for exploration, experimentation and self-expression. What's more, the game was not allowed to have a pre-defined winning state and should include as many players as possible by offering various playing styles.

In three years, we developed over thirty games in the swimming pool that were tested with end-users (children aged eight to twelve), peers (fellow students), and domain experts (students of Fontys School of Sports and ROC Sport). One game stood out of the rest for creating an autonomy-supportive experience. Its design process revealed three useful guidelines for autonomy-supportive games.

1. Analyze existing playful behavior. Designers were tasked to see what kind of playful activity was already taking place in the swimming pool.

2. Determine the restructureable elements in the play. Designers searched for fixed and restructureable elements in the witnessed activity: What could players (and designers) change, rearrange or manipulate that made for an engaging activity?

3. Support restructuring practices by facilitating tools for self-expression and social negotiations. When the playful activity was set, designers were asked to resonate this experience by offering digital means that elicited discussion about the game and that offered various ways to play the game.

Figure 37: Swimgames.nl analyze playful behavior, depict the restructuring elements and facilitate tools for self-expression

Figure 38: Swimgames.nl facilitate tools for social negotiation. This is the projection wall of Plons featuring suction cups

The next sections take a closer look at analyzing existing playful behavior, determining restructureable elements and facilitating tools for self-expression, and social negotiation. The game design process of the swimgame *Plons* will illustrate the steps.

Analyze existing playful behavior
First students observed what kind of activity was already taking place in the pool. One group of students discussed the game of *Cannonball*. In this game, swimmers jump into the water to make a huge splash. When players resurface, they tend to ask others about the quality of their splash: Was it big enough?! After that, players climb out of the water, wait their turn, and jump another time. This ritual repeated itself 3 to 4 times until players decided to do something else.

Determine the restructureable elements
After the observations, activities that had some restructuring quality were set-apart. These activities would fuel the game design process. Students decided that the following aspects of playing *Cannonball* had restructuring qualities:

1. The players' body;
   (Players can rearrange the position of their body-parts.)

2. The water;
   (Players can manipulate the water by plunging into it or by shoving it aside.)

3. The social negotiations in and out of the pool.
   (Players can change the meaning and value of a splash by negotiating with others about their performance.)

Facilitate tools for self-expression
During the initial design phase students focused on the existing value of *Cannonball* play. Students tried to electronically measure the height of the splash by video-capturing the splash with a digital camera. The higher the splash, the more points players scored. In this initial game, players could play with two restructureable elements: the player's body and the water.

Still, the full experience of *Cannonball* was not captured. For one, the scoring system diminished the social interactions between players and audience to sentences like "Mine was higher." Secondly, it proved technically challenging to differentiate water movement from other movements in and around the pool. This made it virtually impossible to estimate the height of a splash by digital means.

Facilitate tools for social negotiations
In order to bring social negotiations 'back' in the game, students gathered all 'splash' recordings on a projection wall. The projection wall featured suction cups. Players could determine the value of a splash by granting the video recording a suction cup. As a result, players stuck a cup near the video recording, which they found most interesting. The suction cup video wall elicited rich social negotiations about the performed splashes. Some debated the height of the jump, whilst others exclaimed their awe over acrobatic back flips.

The social negotiations changed the game. After a couple of rounds and some intense debates, players started to change the rules of the traditional *Cannonball* game. Instead of focusing on the splashes, the dives themselves became of importance. Players changed their posture, made up new dives, and discussed which dive was most beautiful, hilarious or acrobatic. The change in play caught the attention of a group of girls. While the original *Cannonball* was predominately played by boys at first, *Plons* invited girls as well, turning it into a diving game.

Breaking down the design from dynamics
This design-from-dynamics-approach followed a process in which students first analyzed existing playful behaviors in the swimming pool (playing the original *Cannonball*). Then determined the restructureable elements of this play:

1. Posture.

2. Water.

3. Meaning/value giving processes.

Finally, students facilitated digital means to support these restructureable elements. They facilitated

1. Tools for self-expression:

    a. Video capturing the jump;

    b. Video projection wall.

2. Tools for social negotiations:

    a. Video projection wall;

    b. Objects (suction cups) to personally value playful acts.

The design-from-dynamics approach opened up the possibility for players to create their own game mechanics. The designers merely suggested particular rules (e.g. entitling the installation *Plons*, which means splash in Dutch), but did not enforce new rules upon players. As a result, players were free to play with their body, the water, and the rules of the original *Cannonball*.

As said, students did not add new rules and regulations to the playful activity of *Cannonball*. Their design of game mechanics can therefore be considered minimal. The suction cups were deliberately abstract objects. For example, there were no suction cups that said 'most original jump' or 'highest splash'. Instead, players could self-determine the value and meaning of a cup.

Students did not design for a specific experience (except for an autonomous experience). If they did, the experiences resonating from gameplay might have been less diverse. For example, the original *Cannonball* can be associated with PLEX's (Lucero & Arrasvuori, 2010) experiences: thrill, competition or challenge. By opening up the game to the players: *Plons* supplemented the original *Cannonball* game with experiences of discovery, exploration, expression, fellowship, humor, sensation, subversion and sympathy.

Students focused on resonating existing dynamics, making the playful activity by facilitating tools to for self-expression and social negotiations.

Recent developments in the game industry show a similar approach to game design. Mechanics that were unchangeable in the past are now subject to continuous negotiations between players, developers and the game itself (Glas, 2010). The next sections will show how games can no longer be considered 'formal systems that provide informal experiences' (Juul, 2005), since the rules are not authored (e.g. formalized) by the designer alone. The role of the game designer is changing. Game designers are not the sole author of the mechanics, dynamics and aesthetics. Instead, they are becoming facilitators of play, presenting players with ownership of form, environment and style.

Traditionally, the work of game designers includes a wide area of creative work. They code, design and shape visualizations of the videogame. Large game companies (Guerrilla Games, Activitson, Blizzard, BioWare, CCP Gmeas, Core Design, etc.) bring forth a fragmentized workspace in which programmers, asset-developers, graphical artists, audio designers, writers, managers and game designers work on one game. All team members contribute to the gameplay from their respective specialism. But frankly, it is the game designer whom remains the sole author of the game's mechanics. It is the designer who takes the final decision about the toughness of an end-boss, whether or not a game contains a warp-zone, or if a special attack requires a three- or four-button combination.

A game designer is an artist, iteratively creating the game's mechanics to construct the optimal game-flow. As a direct consequence of the authoring behavior, gamers can either comply with the game mechanics or deviate from them. Within strongly authored games, gamers cannot restructure essential game mechanics, let alone construct something new or personal (like we witnessed in *Plons*). The gamers' restructuring activities mainly concern the dynamics and aesthetics of the game. This becomes particularly clear in online role-play.

In (online) role-play players adopt a particular persona. This persona can be pre-defined by designers and follow a specific story line or can be player constructed. In some Role-Playing Servers of the online game *World of Warcraft*, players create elaborate backstories and define a particular personality of their character.

3.3 Abdicating authorship

For example, my role-playing character in *World of Warcraft* was Jakob van Mearland, an enthusiastic gnome from Gnomeregan that tends to banter and boast about his power and fierceness (of which he possesses none). Without leveling my character I traveled the world and asked high-end players to escort me to high-level areas, to which players would normally only go when they played halfway through the game. This is one way in which I defied the game mechanics and played in a way that was meaningful to me.

Role-players change the meaning of game mechanics all the time. More than often, this occurs through negotiations within the online community. Sometime players even change the meaning of particular items. For example, in *World of Warcraft* (Blizzard Entertainment, 2004), an Aurora Robe signifies +54 points on armor, +5 stamina, and +15 spirit. This means that the robe (which can be worn by characters), has various attributes that help players in their fights. However, the Aurora robe has other qualities that are less pre-defined by the game designers. For one, it is a white dress. Instead of boosting their stats, role-players could use the Aurora Robe as a fancy white dress for role-playing parties. The stats of an Aurora Robe are not particularly high, which means that most players in combat will not wear them. However, when role-playing, the robe is used in another way, suggesting that its meaning is reconsidered.

Gamers can give new meaning to objects, activities and goals in a game, as a result they create new dynamics and aesthetics. This happens a lot, however, players can seldom restructure the game's mechanics. These mechanics are heavily authored by designers. Authored games are games as Salen & Zimmerman (2003) define them: Artificial conflicts, based on rules, with quantifiable outcomes. In their perspective, the designers wield the scepter. They decide what can, and what cannot, be done.

Figure 39: Although not officially designated as a Role Playing server, the Proudmoore server in WoW witnesses various play forms that differ from the beast slaying and raiding activities that are more prominent on other servers. This picture shows a Proudmoore Pride, celebrating diversity in sexuality and race in the game environment

Figure 40: The Aurora Rope is used for a variety of activities. See Thottbot for more information on the Aurora Robe: http://thottbot.com/i6415

Not all game mechanics are heavily authored however. For example, the game mechanics of MMORPGs, Social Games and User-Generated-Content Games appear less authored than the traditional retail titles are. In these games, gamers and designers negotiate about the mechanics. This enables the restructuring of formal rules and regulations, the construction of new mechanics and alternative playing styles.

This becomes clear in *LittleBigPlanet 2* (Media Molecule, 2010). The game basically consists of two parts. One is a collection of small games in which players can collect various objects. These objects can be used in the second part of the game, which is the game-creation part of the *LittleBigPlanet 2*. Media Molecule claims that the game designers have exactly the same tools at their disposal as players would, illustrating how authorship of game designers is gradually becoming diffuse. It appears that designers wield the scepter in different and decreasingly authoring ways. Instead players and designers appear to become peers as they can have the same tool set at their disposal to create games.

In order to design from the dynamics, game designers can abdicate authorship over the game's mechanics and aesthetics to the players. As a result, game designers can be to players what a sidekick (or 'straight man') is to a comedian. A comedian's sidekick does not have to be exceptionally funny. Instead, a sidekick can set the stage with a mundane problem or issue, which in turn can be ridiculed by the comedian. In other words, a sidekick can supply the comedian with cannon fodder to shoot at. In comparison, a game designer can supply players with restructureable elements to play with.

Game designers can facilitate alternate points of view, knowledge, skills, or anything else for a gamer to play with. In turn, players can create their own game by rearranging the restructureable elements presented by the game designer. Instead of rewarding gamers for compliant behavior, or punishing cheaters for deviating from them, game designers can inspire, enrich, and empower gamers, by creating games that are less about complying, and more about playing.

By abdicating authorship, designers can create autonomy-supportive games that empower players to restructure game elements. As a result, players can construct their own game.
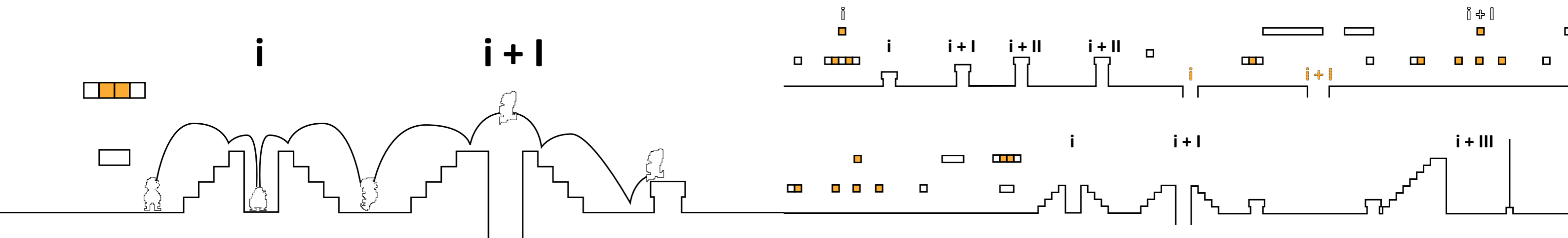
3.4 Gradually increase autonomy-support

Abdicating authorship is not without its share of obstacles. Section 2.3 already discussed how difficult it is to present students with gradually more autonomy and with more responsibility about their own learning progression. A similar issue concerns autonomy-supportive game design. Players and designers may not yet be accustomed to this high degree of autonomy-support. In a way, players and designers have corresponding habituation issues as students and teachers. The way to remedy these issues may correspond with educational design practice as well.

Game designers are well aware of habituation issues amongst players. Players are seldom 'dropped' into an environment and asked to figure out the game by themselves. Instead, a game often follows a well laid out process of progression. Players start with learning the basics of a game and are consequently educated in overcoming increasingly harder challenges.

Casual Games appear to follow the popular mantra: 'easy to learn, but hard to master'. In this statement lies the central point of this section and a main concern for designers: Namely, how to educate players to play the game? This applies to questions such as: Does the game educate players properly? Does it build forth on players' competencies? And does it communicate players' progression well enough? These questions are all well cared for in the next example of the platformer game *Super Mario Bros.* (Nintendo EAD, 1985).

Progression in games can follow an incremental growth of difficulty. The first level of *Super Mario Bros.* illustrates how this can be subtly integrated into gameplay. In Figure 41a typical *Super Mario Bros.* scenario is portrayed that illustrates the process of scaffolding play. The player needs to overcome a small cleft of two slightly different pyramids constructed by two facing triangles. At pyramid 1 (the left pyramid), the player might drop Mario in the space between the opposing triangles.

Falling in the cleft has no huge consequences; it only slows the pace of the game. At the second pyramid falling into the cleft results in immediate death. At the first pyramid, the player develops a skill to jump across small and safe cleft (marked with [i]). At the second pyramid the stakes are higher, so the skill needs be mastered [i + 1].
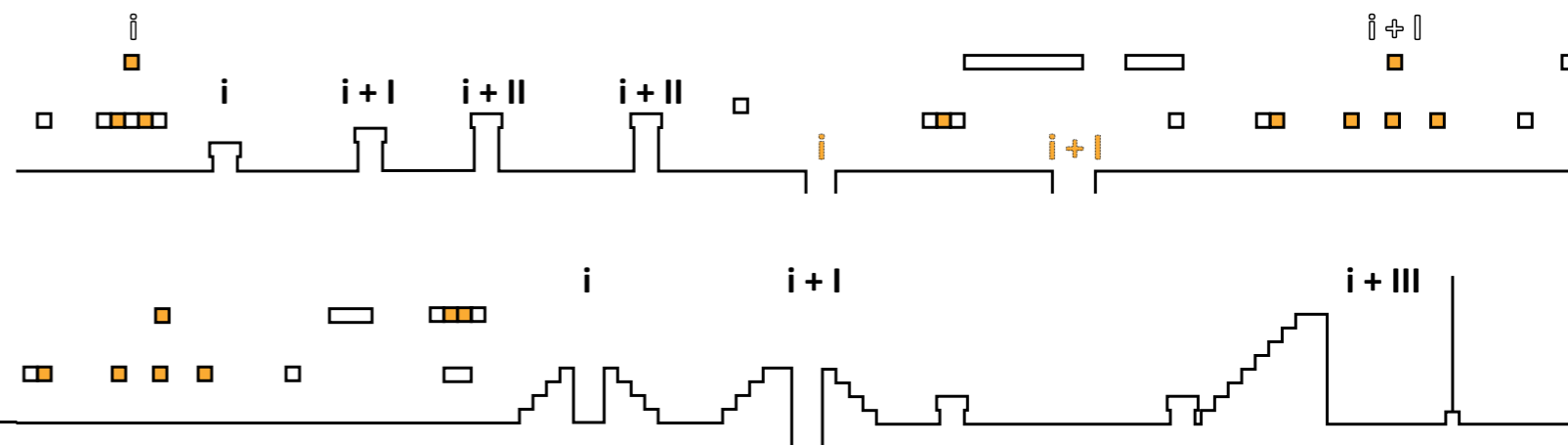
The skill development of jumping clefts is highlighted in Figure 42 with [i], indicating new skills, and with [i + 1], indicating skill development. *Super Mario Bros.* is not a game of balancing challenges, but it is a game of subtle progression. Players can only progress if the skill is mastered, but offer a place to fail first. This means that the skill is educated by the game. As such, *Super Mario Bros.* offers progression in skill development. The subtle incremental growth of difficulty raises the actual competence in negotiating with the game procedures.

It can be argued that this kind of level design is not very autonomy-supportive. Players are punished for falling in the cleft, and there is a limited time to overcome all obstacles. However, The latest part of *Super Mario Bros.* illustrates a more autonomy-supportive design decisions. At the end of a level, players can complete the level by jumping onto a flagpole. In level 1-1 there are two ways to complete the level. The first is the easiest one. Players fall down the high half-pyramid, walk towards the flagpole, hit the jump button and Mario jumps on the lower end of the flagpole. The flag will come down and the level is completed. Players learn that the flagpole signifies the end of a level, and that jumping onto the flagpole results in a particular score.

The second way of completing level 1-1 is more difficult than the first one. In terms of [i + 1], it would be more accurate to qualify this challenge as [i + 3]. If players wish to score more (bonus) points at the end of level 1-1 they need to jump into the flagpole at the highest end. To accomplish this, players need to remain on top of the half-pyramid, and perform 3 new actions: 1) press the run-button, 2) take a small run and 3) jump across the open space onto the top of the flagpole. If this is the first time that players play the game, we can assume that this is the first time players need to use the run button [i + 1]. What's more; it's the first time they use the run button in combination with a jump [i + 2]. And lastly, they learn that jumping higher on the flagpole results in a higher score [i + 3].

The [i + 3] example above is particularly intriguing in regard to players' ability to perform the running jump. It will take a couple of levels before the running jump becomes necessary to complete the game. It would therefore not make any sense to introduce the jump in earlier stages. Especially not when one considers the scaffolding approach of [i + 1] (see section).
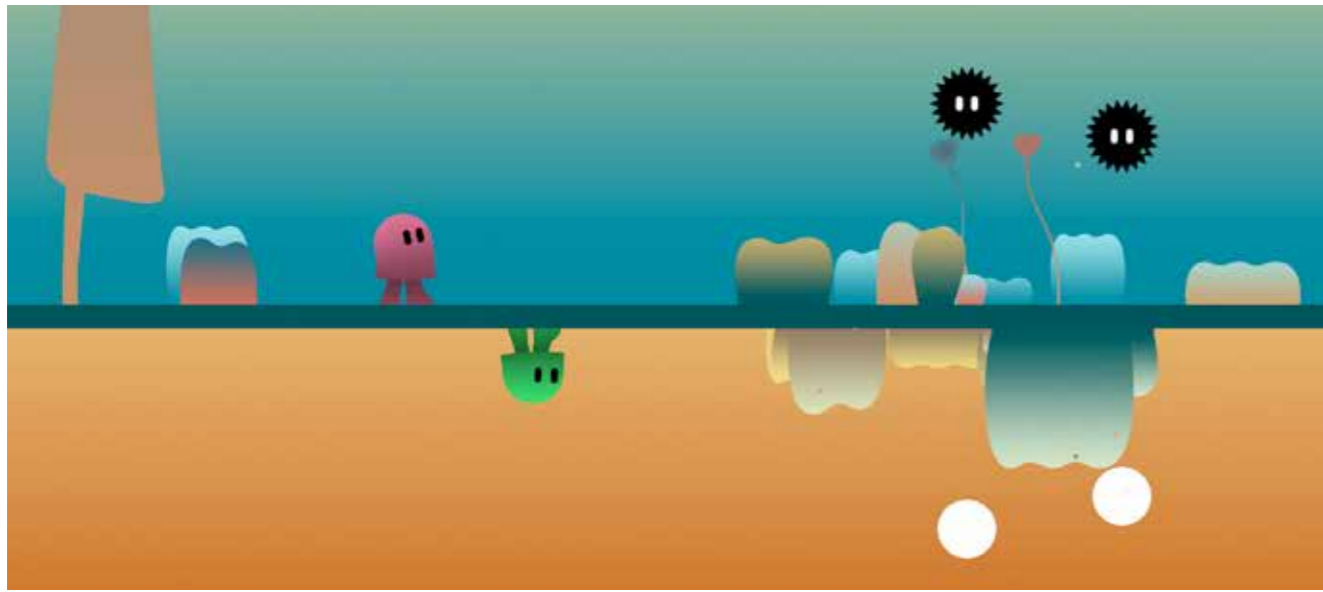
An obvious answer is that Miyamoto may have taken replays into account when designing the first level, since there is no save-functionality in the game. Players can learn the running jump in a later stage of the game. When they replay the first level, they'll take this knowledge with them, and will probably be able to take advantage of the acquired game capital (Consalvo, 2009). The knowledge gained in the later levels will be of value in the first levels.

Other games present different levels of difficulty in one level as well. They present players with apparently unsolvable challenges in the first levels, in order to stimulate players to revisit these levels. In the puzzle platformer *Braid* (Number None, Inc., 2008), players discover an apparently unreachable puzzle-piece in the first level. Only when players learn new ways to play, they will be able to collect the puzzle piece. In the co-operative puzzle platformer *ibb & obb* (Sparpweed Games, 2013) players can use the other player-character to reach higher places and fetch crystals. Some of these crystals appear unreachable at first. However, when players learn to control the two little characters in tandem, players may fetch the crystal in a replay.

The examples above show that level design can present players with various difficulty levels in one game level. Designers educate players by adding extra challenges to elicit replays of levels. As a result, players may find themselves discovering a new ability and thinking: "What if I perform this jump, in that way, to that one piece of puzzle in the previous level?"

The incremental growth of difficulty [i + 1] combined with [i + 3] offers players more ways to play the game. The learning progress discussed above mainly relates to gameplay skill training. Autonomy is therefore related to players' competency level.

The [i + 1] principle can also be used to educate players in autonomy-support, hereby bridging a gap in challenging the habituation issues that are related to supporting autonomy. Basically, it all comes down to presenting players gradually with more freedom and more opportunities to generate their own path to a solution. Let's start with the first: Gradually increased autonomy by presenting meaningful of choice.

Figure 43: ibb and obb does not enforce players to collect crystals, but the crystals do steer players' movement in the game

Figure 44: Braid level select screen situates different rooms with parts of a puzzle. Players are stimulated to collect all missing pieces

Autonomy: Gradually more freedom

The gradual increase of freedom is one way to educate players in autonomy-support. This is clear in *Braid*. In *Braid* players need to solve puzzles by rewinding time. In the puzzle platformer, players can jump around, freeze time, rewind and forward to their liking. Players will see their character move in exactly the way it was moving. Enemies will jump back to life and objects will move back into place. Some objects will remain unaffected by the time change, and here is where the puzzle element comes in. Players need to figure out how to reach a piece of puzzle by forwarding and rewinding their steps through a level.

In *Braid*, players do not need to gather all pieces of a puzzle in order to progress to the next level. Still, the first couple of levels are mandatory. In these levels, players learn the basics of the game (jumping, changing time, etc). After these, the completion of a puzzle will unlock various levels, instead of only one. As a result, players can partly self-determine where to go, but are taught how to play in particular levels first. This way, players learn to understand the boundaries of the game and may be able to explore, experiment, and struggle with the game in later levels.

Braid first simulates the teaching role of the instructor: instructing players what to do next. Only when particular skills are presumably developed, *Braid* models the reaching role of the facilitator. It lets players loose to find a solution to a challenge. *Braid* gradually increases the freedom of choice in accordance to an assumed skill development process.

In order to build a game that gradually presents players with more freedom and autonomy-support, designers need to really understand their users. Designers need to know how fast players develop specific abilities, in order to create a synergy between the players' abilities and the autonomous play presented. It goes without saying that this is a tough design challenge, since every player is unique and has a different level of competence and a different pace of progress.

This difficulty can be illustrated with *Pokémon X and Y*. A game journalist on GameTrailers.com (2013) comments that *Pokémon X and Y* "Has a painfully slow start. […] It felt like the pacing was bogged down by meaningless chatter and dull objectives". The slow start of the latest *Pokémon* game builds forth on its five predecessors.

The relatively simple rock-paper-scissor formation of *Pokémon Red & Blue* has evolved into a complex system of 721 different pokémon species. In addition, *X and Y* sports many new features.

For veteran players, like the aforementioned journalist, these new features will be fairly easy to understand, since they build forth upon knowledge that was gained in the previous games. Newcomers to the series will learn a large body of knowledge. For these players, the slow pace may prove rather underwhelming.

Designers of *Pokémon* resort to textual cues and explanations to educate players. As a result, designers model the teaching style of an instructor. *Pokémon* games typically 'open-up' (e.g. become more autonomy-supportive) when specific challenges are met. Experienced players can revisit old and explore new routes, battle arenas and trainers. Players who overcome challenges may understand the basics of the game. From that moment on, play can be facilitated instead of enforced.

Super Mario Bros. approach towards presenting gradually more autonomy differs from the instructional and explanatory tone of *Pokémon*. The game does not have any textual explanation, nor does it instruct players how to play. Instead *Super Mario Bros.* has players experiment, explore and struggle with the game environment and its associated controls to find out the gameplay by themselves. Hereby players discover themselves what the restructureable elements of the environments are.

Players can change Mario's position, pace, size and functionality (a Fire Flower will allow Super Mario to shoot fire balls). Additionally, players can manipulate the game environment by breaking bricks, opening question mark boxes, solidifying secret boxes, removing foes, gathering coins, etc. Some game elements cannot be restructured. Amongst others, these fixed elements concern floor-parts, solid bricks, certain platforms, etc.

By exploring the restructureable and fixed elements in the game, players learn about the ramifications of the game. Instead of instructing and explaining the ramification, Miyamoto facilitated play. This facilitation can increase players' locus of causality, and can therefore be considered autonomy-supportive.
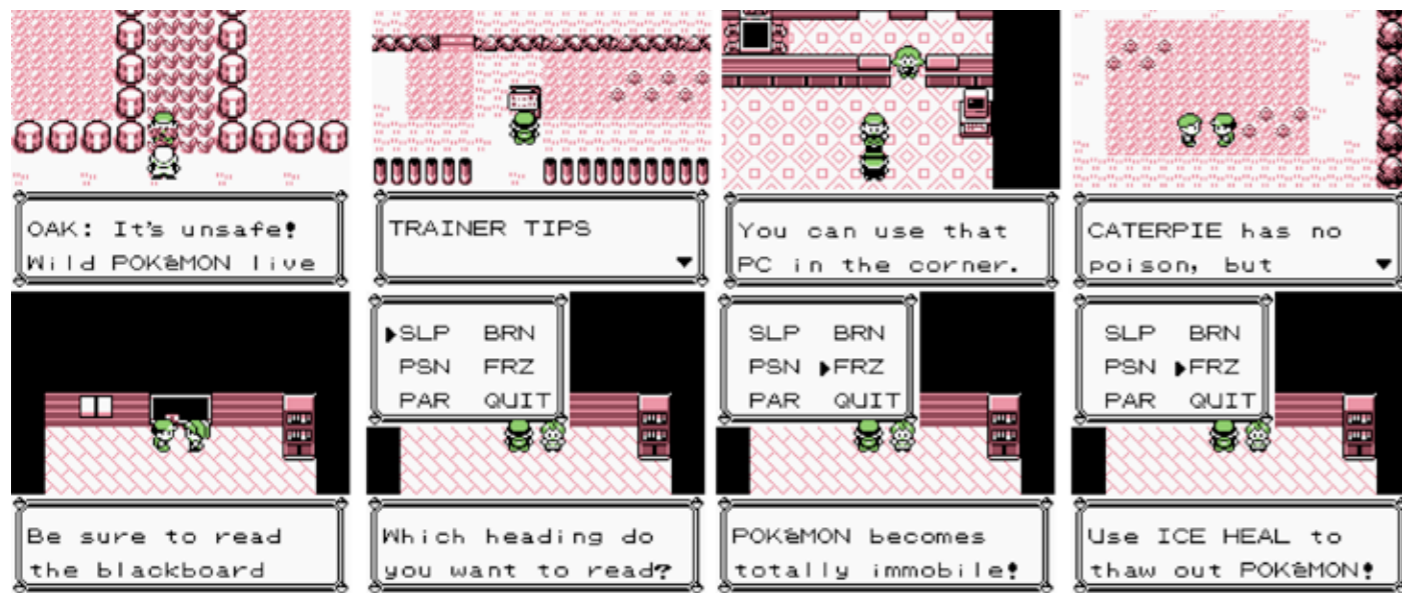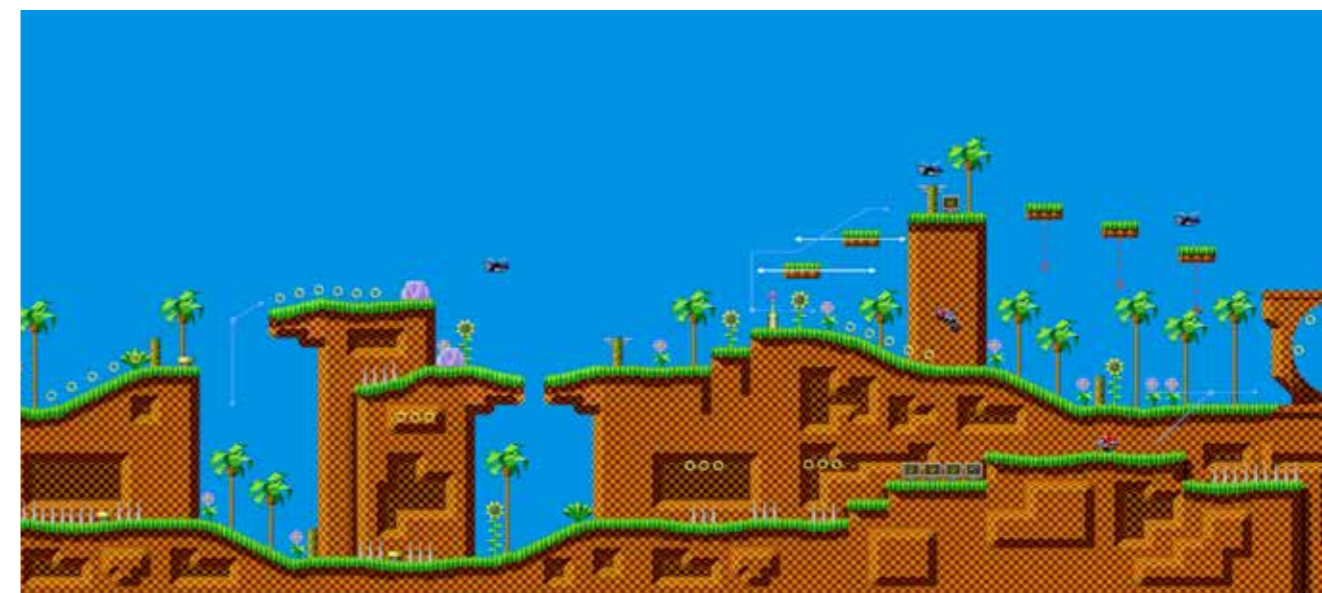
Figure 45: Pokémon resorts partly to textual cues and instructions to explain the game. Still the first installment offers many ways to learn the game through trial & error as well

Figure 46: Various routes through the game level in Green Hill Zone Act 1.

Autonomy: Generating one's own path

Another way of facilitating autonomous experiences is by offering players the opportunity to follow their own path towards a solution. The flagpole jump in Super Mario was an example of this. More clear variants in paths are apparent in *Sonic the Hedgehog* (Sonic Team, 1991). Figure 46 and Figure 47 display level 1 of *Sonic the Hedgehog*. Halfway through the level, players can choose from among three different routes. The first is the easiest one, and sends Sonic through a looping and tunneling cave. The second asks players to move over the looping and through another tunneling cave. The last route takes players through the uppermost part of the level. This is the route with the most jumps and obstacles, and can therefore be considered the most difficult route. As a result of players choosing which, this can elicit an autonomous experience.

Note that *Sonic the Hedgehog* does not enforce one particular route upon players. Still every route represents a particular difficulty setting. As a result, the Green Hill Zone Act 1, can be played a multitude of times, since players with different levels of competency can challenge themselves, taking more difficult paths through a level.

Today's games are increasingly presenting players with various paths to a solution. Game journalists Dierckx & Bartelson (*Trends in Gaming*, 2012) cite game designers, stating all kinds of autonomy-supportive game design decisions: "One of the ways to kill this target"; "There are many different ways to do that"; "Add more choice"; "Choose the type of way you wanna play"; and "A lot of different ways to approach the situation". All these references suggest that these game designers value autonomy-support in their games.

Designers can educate players to become more accustomed to autonomy-support in various ways. This section discusses how gradually increasing gameplay difficulty can be a useful method to train players in gameplay. Additionally, the design approach of embedding of various difficulty paths in the same game environment has players choosing their own route, and may make them feel more autonomous.
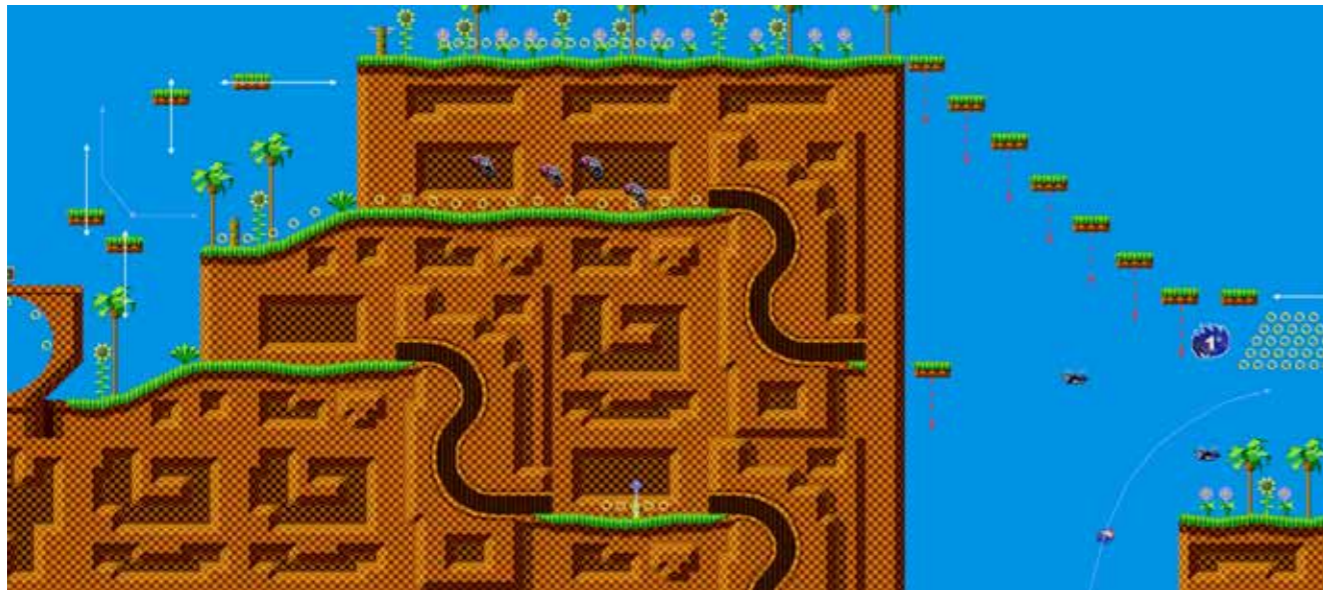
3.5 Design for various playing styles

Following one's own path towards a solution appears an important prerequisite for autonomy-supportive game design. The possibility of generating one's own path presents players with a meaningful choice, since players can self-express their ability by taking more adventurous routes through a level.

This way of presenting players with meaningful choice mainly concerns players ability in successfully overcoming game obstacles. This section will explain how the integration of various playing styles can present players with meaningful choice that is less focused on expressing competence, and more concerned with players' identity - or as Deen, Schouten & Bekker (2011) call it, their playful identity.

The playful identity describes the way we play games and how we relate to the activity. In the Raessens (2006) scholars from various disciplines discuss the playful identity in its broadest sense. Debates range from a comparison between players' in-game representation with players' actual attire, to relating in-game artifacts and gatherings with out-of-game religious aspects. This thesis suggests that the playful identity can describe the way players relate to gameplay. These relations can inform design decisions that may connect in-game playful identity with players' out-of-game identity.

One aspect of the playful identity concerns an individual's playing style. Playing styles describe the way players approach a challenge in a game. This section describes playing styles as design-tools for autonomy-supportive game environments. By designing for a rich variety of playing styles, players can follow a path that relates to the player's 'out-of-game' identity. In turn, this may lead to autonomy-supportive gameplay.

Canossa & Drachen (2009) suggest that designers can define play-personas to foster the design of rich and diverse forms of play. The concept of play-personas builds forth on the work of Cooper (2004). Cooper describes how the definition of a *persona* can help designers in their decision-making process.
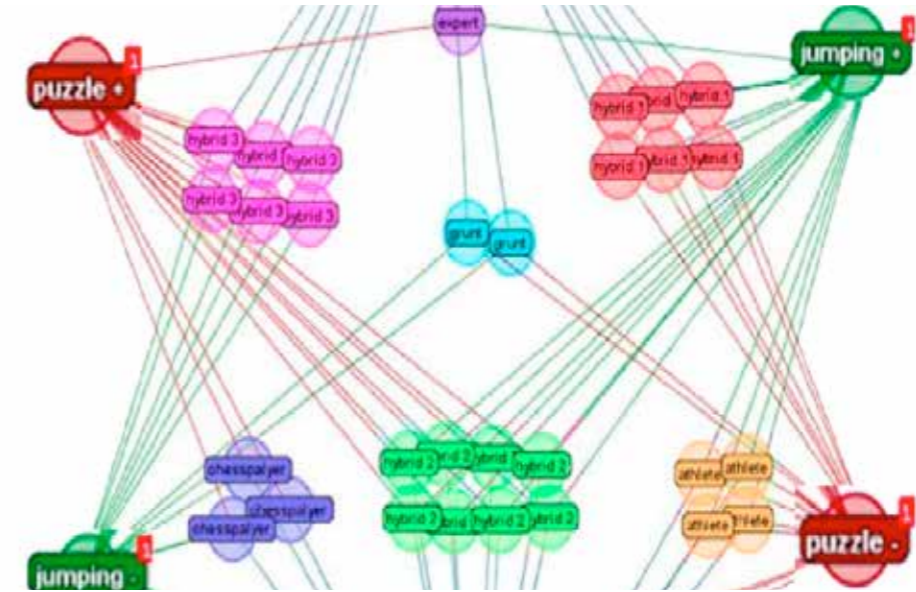
The persona describes a fictional archetype that personifies the targeted audience. Amongst others, a persona has a name (Rob for example), hobbies, physical appearances, a particular level of education and profession. With every design decision, designers can ask themselves: "Would Rob want this?" or "Is this something Rob would like?". It must be noted that Cooper's personas define a stable identity.

According to Goffman (1959), identity is not a stable construct. Instead it is based on interaction; a fluid, active process, depending on context of actions and individual differences (gender, class, ethnicity etc.). It consists of independent and partial sub-identities, which are constructed anew in everyday life.

Identity and interests are not, as suggested by Habermas (1992), settled within the private world, and consequently brought fully formed into the public sphere. In many cases, identity is constituted through experiences, conflicts and other interactions. Today's individuals build and maintain social networks through which they 'negotiate' their identities (Lamb and Davidson 2002).

In the last decade, identity information shifts from being published (self-presentation) to being negotiated, interacted, co-created, and played upon. Describing players by a stable identity may therefore prove a fruitless approach for autonomy-supportive game design. Players seldom show a stable identity, since playful behavior of gamers can be characterized by continuous change (Copier, 2007); players' identities appear to be in a constant state of flux (Deen et al., 2011).

Canossa's play-personas are characterized by *active* attributes. The personas do not describe the *what* of a person, but the *how*. They are not declarative, but procedural. Play-persona frameworks function both as models of preliminary hypothesis of in-game behaviour, and a means for categorizing and analysing character-bound gameplay (Canossa & Drachen, 2009a). Play personas are seldom rigid and unchangeable. Instead, these identities are in a constant state of flux; changing in accordance to the game, the player's intentions and characteristics (Deen et al., 2011).

Play-personas through metrics

According to the works of Canossa (2009b; 2005, 2007, 2008), the ability to deduce and design gameplay for specific playing styles will help game designers to create games for a broader public. In contribution to Canossa's work, this thesis states that the ability to deduce and design for specific individuals may help players to identify with the gameplay on a personal level.

One way of analysing gameplay is by recording all actions of players. The recording of particular player action during play sessions is called data mining. The data mined are called metrics. Traditional assessment metrics in education can be test scores, classroom participation, and time-on-task (Loh, 2012). Gameplay metrics are, amongst others, high-scores, user activity, and the mining of 'player-deaths'. When various players die at the same point, designers can use this information to pinpoint parts in the game that may be too difficult. In turn, this may suggest interventions to ease the difficulty setting of that part of the game.

Canossa & Drachen (2009b) suggest that metrics can be used to deduce play-personas from play-session. Canossa & Drachen used a rich variety of methods such as cluster analysis, factor analysis, and population statistical methods such as ordination/correspondence analysis, to quantitatively analyse an extensive body of 'mined' game-metrics (n = 1000) from *Tomb Raider Underworld* (Crystal Dynamics, 2008). The scholars state that these analyses enable designers to facilitate different play personas, obtain greater insights into possible player types, and to eventually make games that can cater for a broader audience.

One of the play-personas described by Canossa & Drachen is that of the Athlete. The game metrics of this athlete-persona display relatively fast completion times, and show relatively few requests for help in spatial puzzles. Another play persona was dubbed the Runner. These players "Completed the game in record time, but also generally had very high help request rates, indicating a lack of interest or skills in the puzzle-solving element of the game." (Canossa & Drachen, 2009b, p. 8.)

By analysing gameplay metrics, through the 'lens' of play-persona, designers can understand what kind of play behaviour their design decisions elicit. It may also work the other way around. By analysing metrics, designers may discover unexpected ways of play. Iterations on the game could incorporate design decisions to accommodate for these kinds of play, much like the way Fontys students analysed and designed for existing playful activities in the swimming pool. In short: See what is already happening and design tools to resonate that activity or specific playing style.

Play-personas through questionnaires

Yee (2007) utilized another technique to understand why and how players engaged with a game. Yee conducted a large amount of semi-scripted reviews and surveys about players' motives to play Massively Multiplayer Online Role Playing Games (MMORPGs). These motives are largely translated to players' desires. Yee aligns his findings to research in Need Theory, a particular discipline in cognitive psychology that studies human motivation. Amongst others, players of *World of Warcraft* expressed various intentions to play the game. From the findings Yee deduced three main play-motives:

Achievement	Social	Immersion
Advancement Progress, Power, Accumulation, Status	**Socializing** Casual Chat, Helping Others, Making Friends	**Discovery** Exploration, Lore, Finding Hidden Things
Mechanics Numbers, Optimization, Templating, Analysis	**Relationship** Personal, Self-Disclosure, Find and Give Support	**Role-Playing** Story Line, Character History, Roles, Fantasy
Competition Challenging Others, Provocation, Domination	**Teamwork** Collaboration, Groups, Group Achievements	**Customization** Appearances, Accessories, Style, Color Schemes
		Escapism Relax, Escape from Real Life, Avoid Real Life Problems

Table 2: The sub-motives grouped by main-motive, Yee (2006)

1) **Achievement:** The desire to gain power, analyse the underlying rules and challenge and compete with others.

2) **Social:** The desire to help and chat with others, form long-term relationships, and belong to a group effort.

3) **Immersion:** The desire to escape from real life problems, the ability to customize a game-character and create a persona with background story, and to play-out this role.

Yee added various sub-motives to these three main-motives (see Table 2).

This rich pallet of play-motives illustrates the diverse reasons for play. The rich variety of motives translates to what people do in the game, since one's desires logically translate to one's actions. Yee claims that play motives in MMORPGs (as seen in Table 2) do not suppress each other: "Just because a player scores high on the Achievement component, doesn't mean they can't also score high on the Social component." (2006, p.6.)

Yee connects to Canossa's debate about hybrid play personas in *Tomb Raider: Underworld*. Players could seldom be categorized as a pure athlete, instead they engaged in various playing activities. Players continuously switch from one persona to another, emphasizing the state of flux in which playful identity exists.
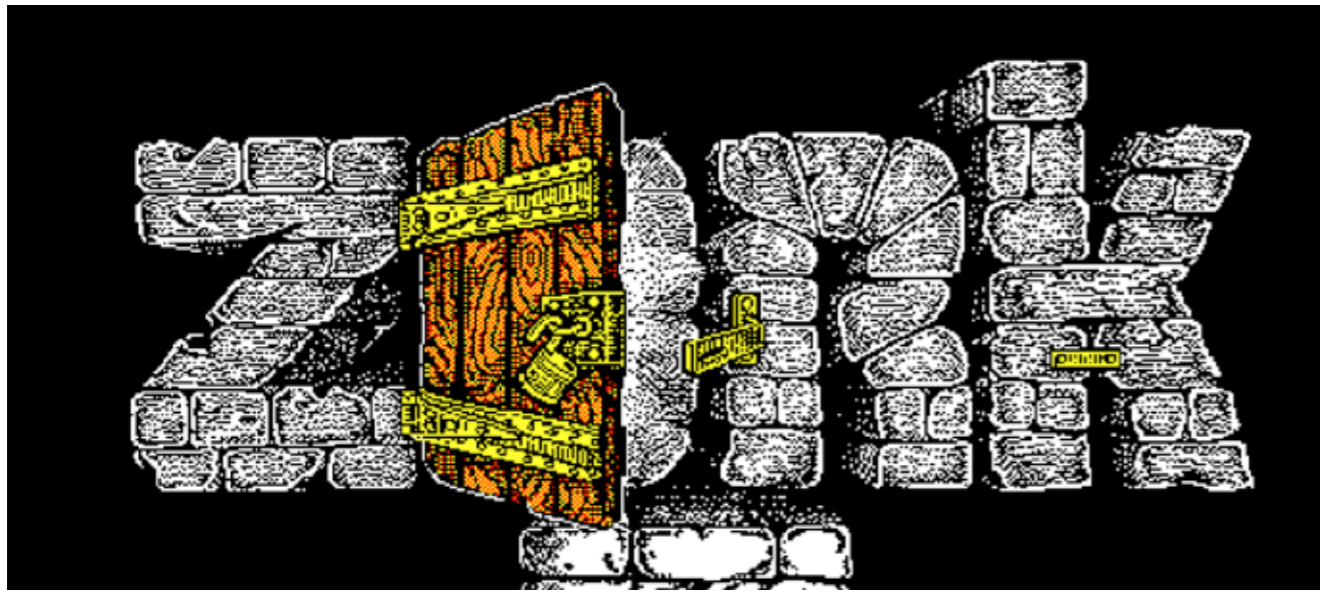
Play-personas through ethnographic research

Game researcher and designer Richard Bartle (1996) concurs with the hybridity and changing character of the playful identity. Forgoing the research of Yee and Canossa, Bartle analyzed the playful behavior of players in Multi User Dungeons (MUDs). These Multi User Dungeons (or Dimensions) preluded today's MMORPGs. Players from all over the world entered these online environments to play, socialize and immerse themselves predominantly in the world of *Dungeons and Dragons* (Gygax & Ameson, 1974).

In MUDs players can engage with one another or with the world itself. This world is described by text. By inputting commands players can move around in this text adventure. For example, the first steps in *ZORK* are as follows: (the bold text signifies user input)

> You are standing in an open field west of a white house, with a boarded front door.
> There is a small mailbox here.
> **>open mailbox**
> Opening the small mailbox reveals a leaflet
> **>read leaflet**
> (Taken) "WELCOME TO ZORK!
> ZORK is a game of adventure, danger, and low cunning. In it you will explore some of the most amazing territory ever seen by mortals. No computer should be without one!"

ZORK is not a MUD, since it is a single player Text Adventure. Still it paved the way for MUDs in whcih players can wonder around aimlessly or unravel a puzzle from which a storyline emerges. MUDs were later embellished with graphics and later with complete modeled worlds (MMORPGs – Massively Multiplayer Online Role Playing Games). The game *Ultima Online* is considered one of the first graphical online adventures that could be played with others on the internet. Players needed to cooperate to defeat particular monsters. It is in this game where Bartle performed a large body of his research.

Bartle (1996) studied the playful activities in these online game environments. Form his observations, Bartle created a taxonomy of four playing styles that appear dichotomous to one another at first. However, as Bartle claims, players are a hybrid of several playing styles, interacting in complex and changing ways. The four playing styles distinguished by Bartle are: Achievers, Explorers, Killers and Socializers.

The next paragraphs will shortly describe Bartle's playing styles. It will become clear that Bartle's study to playful behavior corresponds to the learning styles deduced by Silver Strong & Perini's (2000) from learning behavior amongst students.

1) **Achievers** regard points-gathering and rising in levels as their main goal. They explore the game world to gain advantage of new sources of treasure and to find ways of wringing more points out of the game. Achievers correspond to Mastery style students in that they are sensitive to acts, details and physical actions. Both are rather pragmatic in their way of approaching a problem. They typically enjoy a hands-on experience and make decisions based on the outcome of the action. This style can therefore be dubbed **pragmatic**.

2) **Explorers** delight in having the game expose its internal machinations to them. Like an Understanding style student they try to figure out how things work. They create conceptual models of optimal strategies and revel in well-planned actions and durable solutions. Because of the highly abstract notion of conceptualizing optimal strategies this style can be dubbed **theoretical**.

3) **Killers** get a kick from imposing themselves on others. These are typically the cheaters and griefers (Consalvo, 2009) in games. However, when the moral implications of cheating, trolling, and griefing are not taken into account, killers correspond well to self-expressive oriented students. These players typically enjoy articulating ideas to express and create. Finding loopholes in the game, and showing off to others. They often use the game in ways the designers did not imagine (or want). In a way, they are not playing the game, they play with the game (Sihvonen, 2009). Therefore this style can be dubbed **self-expressive**.

4) **Socializers** use the game primarily as a context and environment to engage in social negotiations. These interpersonal activities do not always relate to the game, its narrative or the possible strategies available to players. According to Kent (2001), Bartle witnessed players sharing recipes of apple pie while awaiting entrance to a dungeon in *Ultima Online* (Origin Systems, 1997). Surely, a recipe for sword would come more in handy in a mid-evil fantasy game than an apple pie recipe. Still, socializers, appear to appreciate these social aspects over the achieving, exploring or killing. As a result, socializers do not really have to win, as long as they have a good time socially. Clearly, this behavior corresponds to interpersonal oriented students. It is for this reason that this style can be dubbed **interpersonal**.

Bartle's (1996) playing styles correspond well with the learning styles of Silver, Strong & Perini (2000). The list is not extensive, but people can approach challenges in a 1) pragmatic, 2) theoretical, 3) self-expressive, and 4) interpersonal manner.

Understanding of playing styles may help designers to create an environment in which players can generate their own path to a solution. The possible paths can align with the approaching styles described above. In this way players can follow a path that aligns with their identity. As a result, this may increase their locus of causality, and thus the autonomy-support in the game, since players may experiment, explore and struggle with the restructuring possibilities of the game in a personal manner.

3.6 Autonomy-supportive game design

In order to design autonomy-supportive games this thesis suggests that the design process could benefit from starting from activity (dynamics) instead of starting with restrictions (mechanics) or end-states (aesthetics). By starting with a particular freedom, it may prove easier to create freedom for the player as well. One way of designing from the dynamics, from the intended activity, is by regarding play as a restructuring practice. The continuous manipulation rearrangement and alteration of an existing structure to create something new constitutes as play.

Searching for the restructuring possibilities in an environment, learning process or existing playful activity may depict interesting directions to design tools for self-expression and social negotiations. In other words, designers could search for something they / players can change, and develop ways to put 'something of oneself' into the activity that may elicit discussion about the process and its results.

As a direct result from this approach, designers have to abdicate part of their authorship on the mechanics and aesthetics to the player. This means that players can self-impose particular rules and goals. Also they can depict their own meaning and value to the playful activity through social interactions with other players or the designer(s). These autonomy-supportive environments can offer restructureable practices that concern both the players' competency as the players' identity.

Restructuring practices that concern players' competency suggests that designers can gradually introduce new elements to the game. The main rule for this is [i + 1]. Designers can step-by-step introduce new gameplay elements and gradually grow the difficulty level. In order to make the game more autonomy-supportive designers could consider to imbed [i + 2 (or more)] challenges in the game in contribution to the [i + 1] flow. In this way designers can create different paths to a solution that present players with the opportunity to choose a path that corresponds to their level of competency.

Furthermore, restructuring practices that connect to players' playful identity invites designers to integrate various playing styles into a game. This chapter described the design parameters of the Theoretical, Pragmatic, Interpersonal and Self-Expressive players. This list is not extensive but may prove a fruitful approach to connect to players' playful identify. In this way, designers can create different paths to a solution that presents players with the opportunity to choose a path that corresponds with their personality, their playful identity.

In summary, in order to create autonomy-supportive games, designers can search for the restructureable elements (what can you change?), offer tools for self-expresion and social negotiation, and gradually present players with more freedom and paths to explore

4

GAMES & EDUCATION:
THE APPLIED GAME DESIGN MODEL

Parts of this section are based on:

- Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven: Leuven University.

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches.* IGI Global.

- Deen, M., & Schouten, B. A. M. (2014). The differences between Problem-Based and Drill & Practice games on motivations to learn. Presented at the International Academic Conference on Meaningful Play, East Lansing.

SECTION 4 GAMES & LEARNING

Get ready for a math race. Your fuel, correctly answered math questions. Your car, a carefully tuned racing car that can move 2 to 3 spaces depending on how hard the math problem is. The track contains many triggers that can give extra spaces, extra turns, and even keep your car on the track. There are areas in the track where a car coming from behind can knock you off. To get back, answer a math problem correctly. In the end, the one with the most math skills and greatest planning effort will win the checkered flag. (ZenicReverie, 1983.)

In a time where Nolan Bushnell was selling entertainment games like hot cakes, Atari extended its entertainment franchise into the educational domain. The Atari2600 was not only a game console for fun, it was a learning machine as well. One of the games published was the above cited *Math Gran Prix* (Atari Inc., 1982), in which players solved arithmetic formulas to move a racing car forward. The main reason for publishing these edutainment (entertaining education) titles was to motivate children for learning by using game mechanics that would engage children in educational activities.

The rise of edutainment coincided with early academic research into the motivational features of games. For example Malone (1981) searched for correspondences between educational practices and games in regard to motivation. Malone depicted that fantasy was a motivating feature in games. It was hypothesized that embedding fantasy in edutainment would improve players' motivation towards learning.

Malone's thoughts on fantasy as an intrinsically motivating feature in games are still visible in today's educational games. Or as they are called today: serious/applied games. Games like *Math Gran Prix*, *Math Blaster* (Davidson & Associates, 1994) and more recently, *Monkey Tales: Monkey Labs* (Larian Studios, 2009) try to immerse players in an imaginary world that corresponds to children's fantasies of racing, astronomy, and science fiction. Creating this correspondence to child-fantasies asks developers to invest significant resources, since creating vast worlds and elaborate backstories for characters can prove a time consuming endeavor. The resources are spent in an attempt to intrinsically motivate children through the use of fantasy. However, it appears that these resources could have been better spent.

Figure 53: Advertisement for Math Gran Prix

83

According to Habgood, Ainsworth & Benford (2005), attuning to child-fantasies in educational games has little benefit with regard to players' motivation. Habgood states that 'the early 'edutainment' sector became synonymous with this cursory "chocolate-covered broccoli" approach (Bruckman, 1999) - tagging games on to learning content in order to make it more palatable' (2007, p. 9). According to the scholars, this approach is ineffective with regard to students' motivation to learn. Instead, Habgood (2007) and Abt (1971) propose to integrate the learning content (and its associated didactics) seamlessly into the gameplay. According to Habgood, this Integrated Design Approach may increase students'/players' motivation.

The design approach suggests gameplay mechanisms or game mechanics are more critical to effective integration than embellishing learning content with game related fantasies. This thesis contributes to Habgood's suggestion by putting forward a design approach that may help designers to develop games in which players can play with the learning content in an autonomy-supportive environment.

4.1 Autonomy-support in education

In education, the term autonomy-support suggests that students can learn in their own way. Autonomous students are in charge of their learning and they are therefore responsible for their own progress. Autonomy-supportive learning environments can be designed in such a way that students are able to successfully overcome challenges presented. Amongst others, teachers can use the following tools to design an autonomy-supportive learning environment:

1. Adhere to the teaching model of the **facilitator**.

2. Create a **Zone of Proximal Development**.

3. Present various **learning styles** in one course/curriculum.

In Game design these didactic approaches appear to respectively connect to game design approaches. Amongst others, game designers can:

1. Design for restructuring practices.

2. Gradually increase the difficulty and players' freedom in a game.

3. Present various playing styles in one game.

This section will revisit the above notions and present a plan to design autonomy-supportive games for learning by discussing the Model for Applied Game Design.

The facilitator: Section 2 proposed various ways to create autonomy-supportive learning environments. For one, teachers can adhere to the teaching model of the facilitator. Instead of explaining the learning content and instructing students into the right behavior, facilitators have students *experiment*, *explore* and *struggle* with the learning content to find the 'truth' for themselves (Reeve et al., 2004). Students therefore become responsible for their own learning.

Zone of Proximal Development: Section 2.3 elaborated extensively on the habituation issues that come with autonomy-supportive learning environments. With the abdication of learning responsibility comes a particular degree of freedom. Some students and teachers may be unaccustomed to this experience, and may therefore (re)embrace a more positive attitude towards controlling strategies. It appears important to educate students and teachers in autonomy-supportive learning, and have them slowly grow accustomed to the responsibilities that come with autonomy-support.

The design of a Zone of Proximal Development as brought forward by Vygotsky (1978) may prove a feasible approach to bridge the gap between constrictive learning and autonomy-supportive environments. The Zone of Proximal Development creates a 'comfort zone' (Waring, 2006) in which the learning is only a little above the students' intellectual abilities. Students are offered the opportunity to self-determine which learning branch they explore.

Learning styles: Silver, Brunsting & Walsh (2007) urged teachers to differentiate their instruction to accommodate for four learning styles. In an earlier publication, Silver, Strong & Perinni (2000) differentiated a Mastery, Understanding, Self-Expressive and Interpersonal style of learning. The scholars suggest that teachers can create environments in which students can learn in accordance to these learning styles. This way, students can struggle with the learning content in a way that is attuned to their favored learning style.
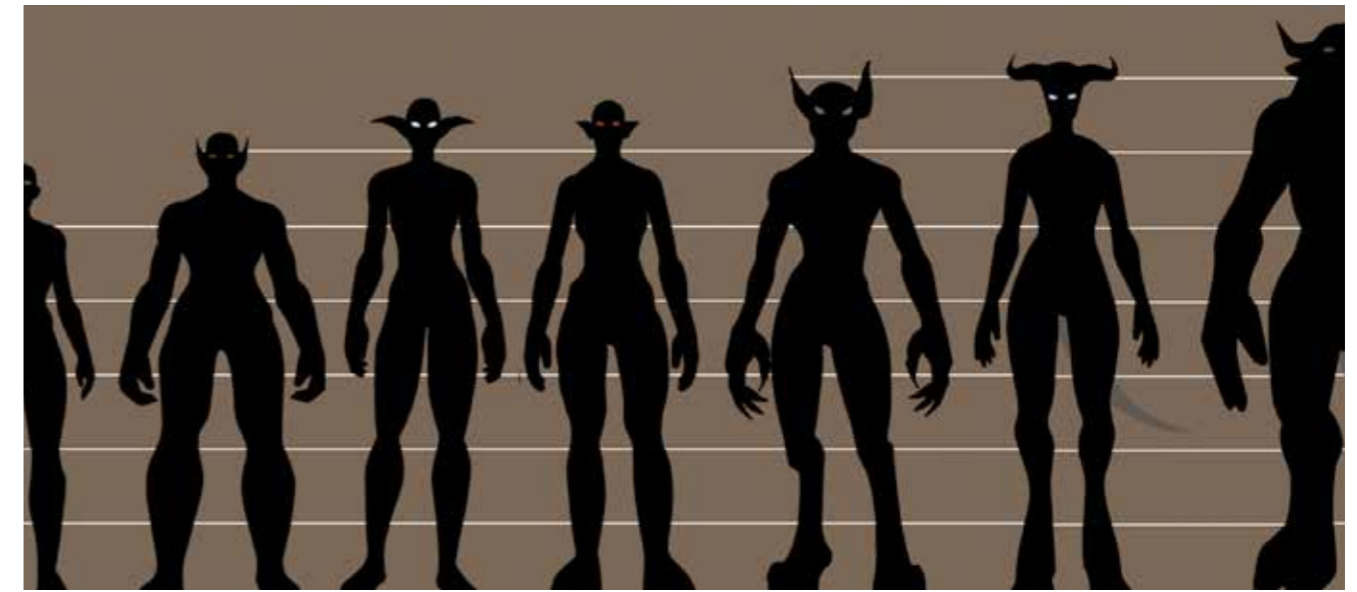
4.2 Autonomy-support in games

Section 3 discussed autonomy-support in games. Like educators, game designers can create games in which players can play in their own way. Most notable are so-called sandbox games (Janssen, n.d.). Games like *MineCraft* (Persson, 2009) *Garry's Mod* (Facepunch Studios, 2004), *Disney Infinity* (Avalanche Software, 2013) and *Little Big Planet* (Media Molecule, 2008) offer players environments filled with objects and rules that can be changed, manipulated, and rearranged.

Restructuring: The manipulation, changing, and rearranging of the existing to create something new appears inherent to playing games. This is what Brock, Dodds, Jarvis & Olusoga (2008) called 'restructuring'. Brock et.al mainly debated cognitive restructuring practices: showing how we play with our imagination when engaging in fantasy play. This thesis brought the cognitive restructuring practices into the physical (or virtual) environment, suggesting that game designers offer players objects that they can restructure. By doing so, they create an environment in which players can play.

One way of designing a game is to search for restructureable elements in an object, environment, rule set or socio-cultural construct. Game designers could ask themselves: "What can I change, manipulate or rearrange in a particular constellation, and which restructuring activities do I want to offer to players and which do I want to author?" As a rule of thumb, the more restructuring practices offered in game, the greater the possibility that the game is experienced as being autonomy-supportive.

Playing styles: Like education, games can offer players various ways to approach the games' challenges. Whereas education is concerned with declaring various learning styles, game designers study the behavior of players to depict play personas. These play personas describe the active attributes of players (Canossa, 2008). They describe how and in what way players play a game, and they connect to what Bartle (1996) calls playing styles (as discussed above in Section 3.5.3). It became clear that Bartle's playing styles correspond to the learning styles depicted by Silver Strong & Perinni (2000).

Bartle's Achiever corresponds to Mastery oriented students. Because of the hands-on attitude of these player-students, I called this a Pragmatic style.

Players who are Explorers correspond to Understanding oriented students. I called this Theoretical style since these people have a more hands-off approach. They typically conceptualize a strategy before acting it out.

Players who are Killers correspond to Self-Expressive oriented students. Despite the negative connotation of Killers, these players are as creative and playful as Self-Expressive students. In order to avoid debates of the moral implication of griefers and cheaters, I reaffirmed Silver, Strong & Perinni's name for these player-students.

Lastly, players who are Socializers and Interpersonal oriented students correspond. Both enjoy the company of others and the social negotiations partaken in and around the play-learning environment above other activities. Games can offer these four learning and playing styles.

Offering various playing styles in one game may benefit the experience of feeling autonomous, since the game offers various ways to play the game in one's preferred way. Games that offer various ways to play have shown to be commercial successes. These include: *World of Warcraft* (Blizzard Entertainment, 2004), *Pokémon* (Game Freak, 1996), and *MineCraft* (Persson, 2009).

Gradually increase difficulty: Games have shown that they can teach players to play exceedingly difficult games without players actually noticing that they are learning the game. Pivotal in this discussion are the first steps in *Super Mario Bros.* (Nintendo EAD, 1985). Players will automatically hit the right cross arrow when prompted with the start screen. Mario will move left, only to be killed by a goomba seconds later.

Players can only avoid the goomba by jumping (pressing 'A') over it. Miyamoto (the designer of Super Mario Bros.) positioned a question-mark brick on the place where player would be most likely to jump over the Goomba. As a result, players would hit the question-mark-brick, uncovering a super mushroom. In less than five seconds, players are educated in the core gameplay of Super Mario Bros: Move to the right, jump over foes, and hit bricks.
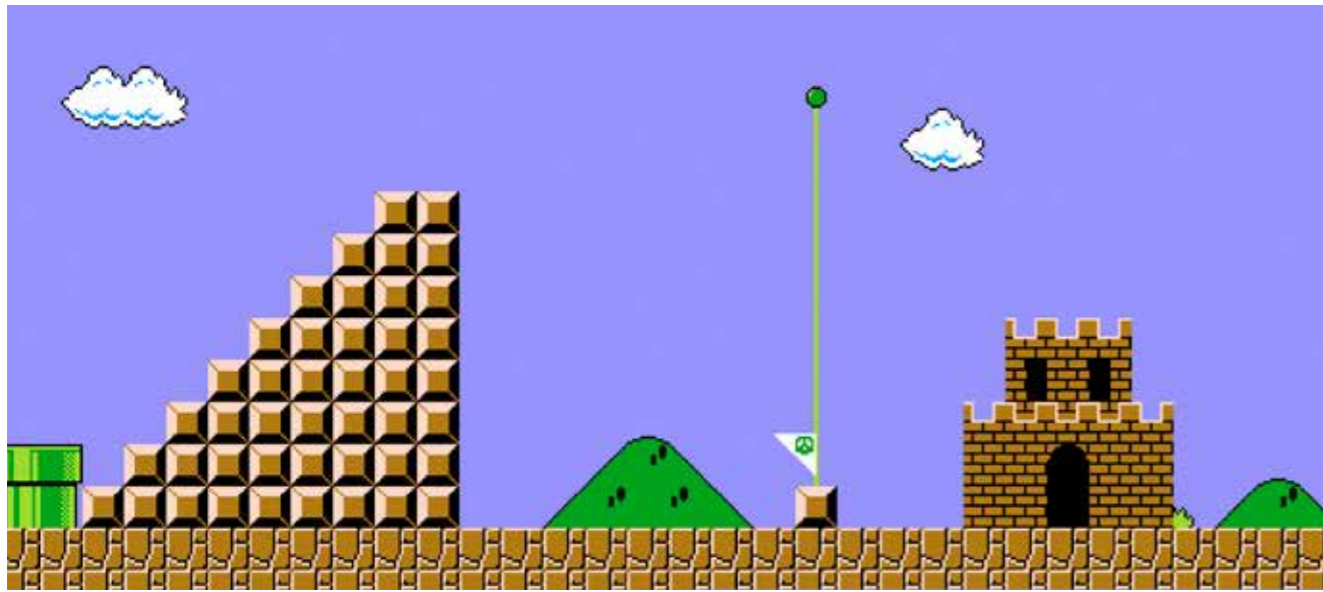
Mario's designer, Miyamoto gradually increases the difficulty of the gameplay by introducing new gameplay elements and variations in a step-by-step manner. This gradual increase in difficulty corresponds to the scaffolding practices in education. What's more, even in a linear and straightforward game as *Super Mario Bros.*, Miyamoto was able to design in accordance to the Zone of Proximal Development, offering various difficulties in one jump (i.e. the Flag-pole jump at the end of Level 1-1).

Today's game landscape offers increasingly more freedom to grow one's competence in playing. *World of Warcraft* is a great example of the Zone of Proximal Development at play in a game. The game world is divided in level-capped environments. Inexperienced players are wise to traverse from lower-level regions to higher-level regions when their competency is met (suggesting a scaffolded learning experience). In addition, experienced players can utilize their gameplay competency to traverse through higher-level areas at their own pace (suggesting a learning experience that corresponds to the Zone of Proximal Development).

Games that are very well scaffolded and offer a Zone of Proximal Development are, amongst others, the side scrolling shooter *Mega Man II* (Capcom, 1991), the puzzle game *Toki Tori* (Two Tribes B.V., 2008), the third person hack-and-slash game *Demon Souls* (From Software, 2009), and the action adventure game *The Legend of Zelda: A Link Between Worlds* (Nintendo EAD, 2013).

4.3 Autonomy-support in gaming and learning

By combining learning and games, a serious game emerges. "The oxymoron of 'serious games' unites the seriousness of thought [...] with the experimental and emotional freedom of active play. Serious games combine the analytic and questioning concentration of the scientific view point with the intuitive freedom and rewards of imaginative, artistic acts." (Abt, 1971, pp. 11–2.) Serious games can be about exploring, experimenting, and struggling with the learning content to find the truth behind the learning for oneself.

From the previous sections we can discern that education and games are not that different when it comes to autonomy-support. The correspondence in didactic approach of social constructivist thought in education with autonomy-support in games partly explains how Habgood's (2007) proposal for an Integrated Design Approach can be accomplished. It also raises an important question: How can we make the educational content an integral part of the game? In other words: How can designers and/or educators develop games that are autonomy-supportive, have students play with the learning content, and have students construct the intended knowledge (and skills)?

Play as restructuring practice: In designing an autonomy-supportive game that has players play with the learning content, the 'magic word' is 'restructuring'. Restructuring suggests the rearrangement and manipulation of existing objects to create something new. Play was already defined as a restructuring practice through social negotiations in a socio-cultural network of human and inhuman actors in section 3.2.

Play is by definition a restructuring practice (Deen & Schouten, 2010). Players always change an existing configuration, rule or regulation when they engage with a game or toy. Through the restructuring practice, the arrangements of actors and their relations to others change. New meaning and new artifacts emerge from the very act of playing.

Learning as restructuring practice: Learning can be considered a restructuring practice as well. Cognitive neuropsychologists (Kok, 2004) explain how our brain can be considered an electrical network. Our brain is made up of nodes and connections. When we learn something, our brain either constructs new nodes and connections, or reinforces particular connections to a node.

For example, imagine an individual who has never seen a capital letter 'N' in their life. When they come across the 'N' for the first time, their brain creates a node: 'N'. The 'N' is learned, and the individual is able to recall the letter without seeing it (i.e. without an external stimulus). A day later, the individual stumbles upon a lowercase 'n'. The individual will search their brain for correlations with knowledge nodes that are constructed already. They find the capital N. As a result, the individual creates a new node: 'Lowercase n' and creates a relation between the capital N and the lowercase n named: 'the letter n'.

Individuals create knowledge that is more than a collection of nodes only. The connections between the nodes add value to them. The neural network of nodes and connections make up for the whole knowledge base of individuals. The nodes correspond to declarative knowledge (facts and figures), and the connections concern procedural knowledge (connections, relations, path-ways, etc). New input adds new notes and connections to the network. In this way the network is changed; its structure altered. Learning incites variations and alterations of the network in order to incorporate new knowledge.

Learning can be considered a continuous restructuring process of existing and new nodes and connections. In the words of Jean Piaget: "To know is to modify, to transform the object, and to understand the process of this transformation, and as a consequence to understand the way the object is constructed. An operation is thus the essence of knowledge; it is an internalized action, which modifies the object of knowledge. [...] Anything is only understood to the extent that it is reinvented." (Jennings, 1967.) In short: Learning is restructuring (knowledge).

4.4   Gaming and learning = restructuring

As Vygotsky (1978) and Bandura (1997) already suggested, this restructuring practice (learning) is largely derived from social negotiations with the world around us. This world is a socio-cultural one, which exists of human and inhuman actors that are all complexly intertwined and connected to one another. Learning (as an activity) can thus be characterized as a restructuring practice through social negotiations in a socio-cultural network of human and inhuman actors. Thus, learning and playing can be characterized as a restructuring practice. The question remaining is: How can *restructuring* help designers to adhere to the integrate design approach as put forward by Habgood (2007)?

4.5   Challenges for the Integrated Design Approach

The Integrated Design Approach suggests that the play activity corresponds to the learning activity. This proves a hard design challenge for teachers and game designers, because it is sometimes difficult to depict what the learning or playing really entails. The next transcript of the television show *StarTrek: Voyager* illustrates this difficulty. In this scene, Icheb tries to educate Naomi Wildman about complementary base pairs in genetics. In an attempt to increase Naomi's motivation towards learning, Icheb tried to make the learning more 'fun'. As a result, Icheb created a puzzle-game. In the scene, Naomi places a tile on the puzzle and says:

[Naomi] Hmm... there!

[Icheb]   Excellent. You recognized the complementary base pair.

[Naomi] Actually, I just found two pieces that fit together.

[Icheb]   You're missing the point.

[Naomi] I thought the point was to finish the puzzle.

[Icheb]   And learn something about genetics.

[Naomi] If you really want to help, find me a green piece that
               looks like Tuvok's ear!

The transcript explains how Icheb thought that Naomi would better understand complementary base pairs by puzzling with them. However, he did not create a puzzle about genetics. Instead, Icheb created a puzzle about visual resemblances. ("I just found two pieces that fit together.") By creating a mismatch between the learning content and the playful activity, Icheb failed to create a game that really educated Naomi in understanding the 'complementary base pairs'… As it turns out, it was Icheb, not Naomi, who was 'missing the point'.

Embellished games with learning content
Icheb's mistake is easily made when designing serious games. It is easy to 'put' the educational value in the game's visual representations and not in the playful activity. For example the game *Super Chick Sisters* (Peta, 2013) tries to educate players about the gruesome way in which Kentucky Fried Chicken (KFC) breeds and butchers animals. In the *Super Mario Bros.* look-a-like, two chickens run and jump through a world that closely resembles the world of *Super Mario Bros.* However, the world of *Super Chick Sisters* is filled with signposts of KFC, and fearsome Colonel Sanders spiders. Players pass by friendly characters, who explain the cruelties of KFC's slaughtering practices.

Super Chick Sisters tries to educate players about animal cruelty (especially regarding KFC), by embellishing a platformer game with an educational message. The game is about timing jumps and estimating distances. This does not correspond with the intended message. Jumping around and animal cruelty are not the same. As such, the intended message does not correspond with actual gameplay. Therefore, *Super Chick Sisters* does not adhere to the Integrated Design Approach, since the educational value is only found in the game's visual representation and narrative.

Embellished learning with game elements
Another pitfall in applied game design is creating a learning exercise that looks like a game, but in essence remains a (digitized) exercise. For example, the aforementioned *Math Gran Prix* merely embellishes calculation exercises with racecars. The analog exercise is hidden underneath a layer of game-like elements: racecars, competition and scoring-points.

The game remains a digitized learning exercise, since the embellishment of the exercise did not really change the way students can solve the calculations. What's more, there is only one path to the solution. Thus, the game is not very autonomy-supportive, but rather drill and practice oriented.

A learning intervention with two separate entities
The last pitfall depicted by this thesis is that of the 'hybrid game'. These applications have students learn, than play, and then learn again. In a hybrid application, the playful activity and the learning activity are separated. In a hybrid game, the game and learning exercise are two absolute entities.

For example, in *Math Blaster* (Davidson & Associates, 1994) players must solve arithmetic calculations (the learning exercise) in order to power a tractor beam. When students successfully solve five formulas they can use the tractor beam to clean the universe of floating garbage (the game part).

In hybrid games, students are rewarded with a small game if they successfully complete a learning exercise. Again, the learning does not correspond to the play, since they are separated. Therefore, hybrid games do not connect to the Integrated Design Approach.

Mismatch between knowledge construction and gameplay
Other pitfalls in serious game design are well covered by Egenfield-Nielsen (2005), Habgood (2007), Aldrich (2009), and Abt (1971). Some games merely embellish learning exercises with fantasy themed visuals (e.g. the Chocolate Broccoli Approach) or vise versa. Other games actually consist of two different entities: a game part and an exercise part. All three approaches mismatch the learning and the actual gameplay. Therefore, the game does not concern the intended knowledge construction. It is therefore reasonable to assume that the game did not meet its objective.
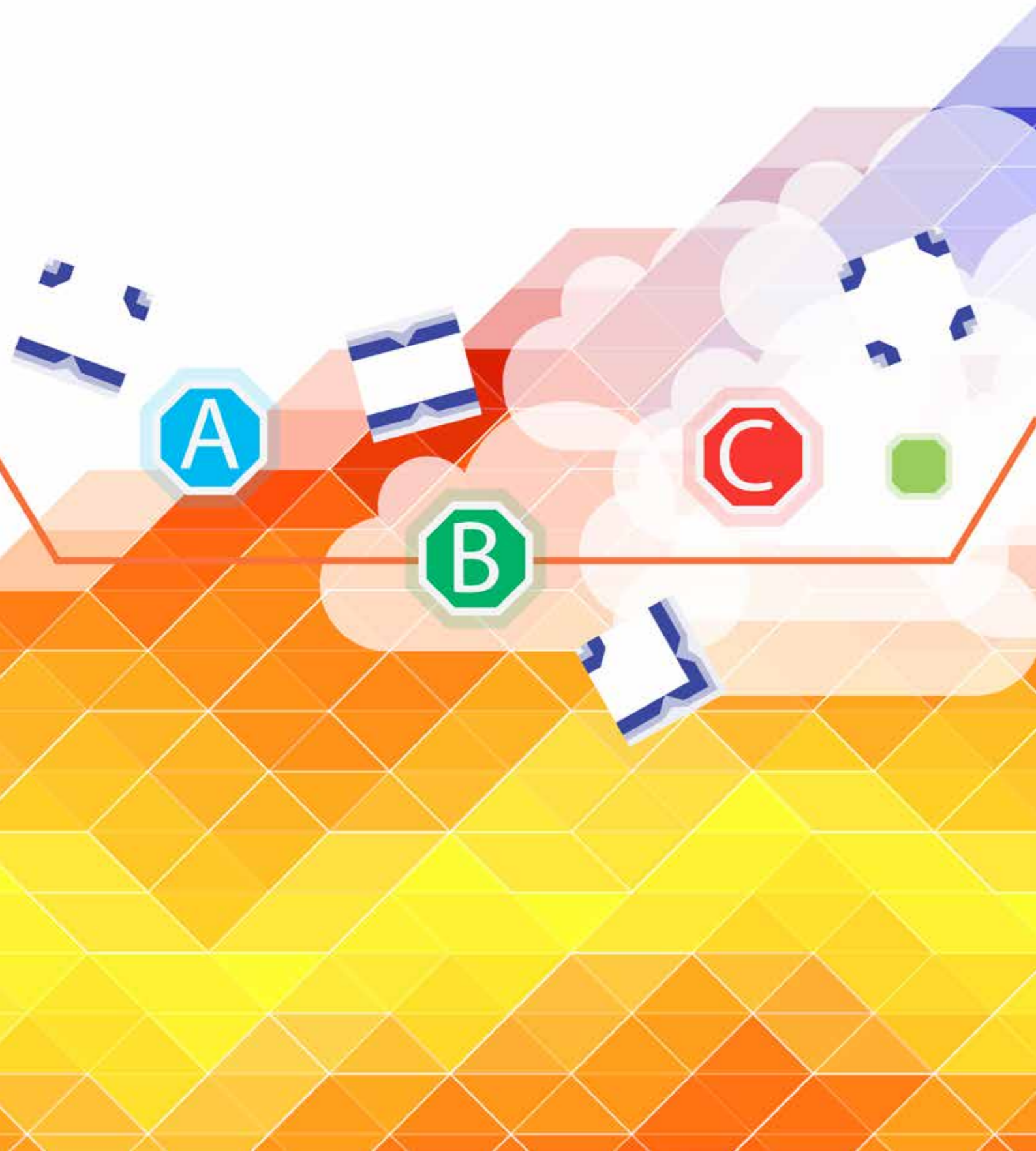
In order to create a game that is really about the learning, designers should understand what the learning is actually about. Searching for restructureable elements in the learning content may help designers to create a game that is actually about the learning content, and avoid the above pitfalls of creating two separate entities, or the merely tagging of games onto learning.

5

10 STEPS
INTEGRATING LEARNING WITH GAMEPLAY

Parts of this section are based on:

- Deen, M., Heynen, E. J. E., Schouten, B. A. M., van der Helm, G. H. P., & Korebrits, A. M. (2014). Games [4Therapy] Project: Let's talk! Presented at the Games for Health Europe, Utrecht.

- Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven: Leuven University.

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches*. IGI Global.

SECTION 5 10 STEPS

This section describes 10 design steps to transform learning content into a serious game. The steps are illustrated by the development of a game for mathematics education called Combinatorics (Deen & Verhoeven, 2011) in section 6.

1) Define the learning context.

2) Define the learning goal.

3) Define the learning procedure.

4) Determine the restructureable and fixed elements of the learning procedure.

5) Transform the restructureable elements to changeable game mechanics and the fixed elements to unchangeable mechanics.

6) Develop a prototype.

7) Consult domain experts.

8) Prioritize what to instruct and what to facilitate.

9) Revisit domain experts and perform user tests.

10) Iterate upon feedback and finish the game.

The steps above will first be described in the context of *Combinatorics*, a game that educates players in permutations. In the game a dot travels from point A to point B. At every intersection the dot divides into the number of branches of the intersection. It is up to the player to alter existing routes in such a way that a particular number of dots reach point B. This section will describe 10 steps to come from the learning content to a game. The following section will illustrate the steps with the design process of *Combinatorics*.

Figure 61: 10 steps of integrated the learning into the gameplay   95

5.1   Defining the learning context

The learning concept is more often than not broadly defined. This makes for rather fuzzy concepts, which is exceptionally hard to design for. When designing for broadly defined competencies, like methodic knowledge, strategic skills, or social-communicative skills (see Cluitmans et al. (2009), designers may easily be lost in the vast amount of possibilities presented. It is therefore important to narrow the scope and define a clear learning concept. Gladly, educators do this all the time. For example, course-books tend to narrow the educational content down to a clearly defined learning concept.

Serious game design could benefit from collaboration with domain experts. A domain expert is a person or consortium with that poses a thorough understanding of the learning procedure. These domain-experts are typically teachers, scholars, or professionals in the field of the intended knowledge construction. Additionally, designers can find inspiration from existing course-books and course-plans. The clearer the concept is defined, the easier it is to design.

Any topic would do for this study. We chose an educational subject based on a personal dislike. We presumed that if we were able to develop an engaging game for a subject we did not like, we might probably make a game that would be engaging to others as well. Since I never really grasped the notion and value of calculating probabilities or calculating change, we decided to challenge our notion about the subject by making an engaging game calculating possibilities (as a prelude to calculating change).

Although I had the freedom to depict my own learning context, this is usually not the case in serious game development. More often than not, clients bring in a rather specific context, learning direction, or a particular message. Two examples that I will refer to in this Section were delivered during my time at Ranj Serious Games. One from ROC-West Brabant (a vocational learning institute) for second language learning, and another context from the Erasmus University and Erasmus Medical Centre on learning about pandemics.

5.2   Defining the learning goal

When the learning concept is defined it may still be unclear which knowledge the player should construct. The intended knowledge construction can be narrowed down by clearly describing the learning goal. The learning goal presents designers with clear boundaries to work in. If the game does not facilitate players with opportunities to reach this goal, the game may educate the players in something else.

The goal of our math-game was to educate players about various ways to 'smartly count' various possibilities. This learning goal can be taken directly from a course book's chapter (i.e. smart counting in *Numbers & Spaces* (Reichard et al., 2003)). However, clients can depict a specific learning goal upfront. It may be most feasible to define the learning goal together with domain experts and clients. This multidisciplinary approach (bringing together financers, domain experts and designers) appeared fruitful when it concerns the definition of a feasible learning goal.

A learning goal depicts a more concrete description of the intended knowledge construction. For example, the learning goal of the second language acquisition game's emerged from various meetings with clients, domain experts and the development studio. Together the group decided that the game should invite Dutch players to communicate in English in a safe environment. The prime learning was to help students to dare to communicate in another language. 'Dare to communicate' became the main learning goal of the game.

5.3   Defining the learning procedure

When the learning concept is narrowed down to a clear description, and the learning goal is well-defined, it may proof useful to search for an overall procedure that connects activity with goal. This is what I call the Learning Procedure.

Bogost (2007) describes a procedure as a rule-based representation of something and as possible interactions within these rules. Bogost builds forth on Murray's suggestion that "The new digital medium is intrinsically procedural." (1998, p. 72.) Bogost suggests that every message, every intended knowledge construction, can be translated into a procedure; a series of executable rules. "To write procedurally, one authors code that enforces rules to generate some kind of representation, rather than authoring the representation itself." (2008, p. 122.)

By exploring this procedure players are the authors of the final representation, thus they may feel like autonomous agents. Amongst others, a procedure can be described as a mathematical formula, a flowchart (describing every possible step that ties all the executable rules together), an Actor Network (Latour, 2007) or even a simple rule of thumb. It describes the actors of the knowledge (factual knowledge like facts, end-states etc.) and how the actors relate to one-another (procedural knowledge).

5.4 Depicting the restructureable elements

Learning content can be described as a procedure, since there are always particular rules and objects that relate to one another. A learning procedure contains rules, objects, goals (mechanics) and a particular structure (dynamics). In the procedure, some things are fixed. They cannot be changed without altering the learning. For example: 4 x 6 always results in 24. One cannot change the multiplication rule in 4 x 6 = 24 into, for example, 4 x 5 = 24. The multiplication rule cannot be changed if the game wishes to correspond to the intended knowledge construction. I call these 'fixed elements'. In the example, the fixed elements are the x and the =. Fixed elements cannot be changed without altering the intended knowledge construction.

Some aspects of the above formula *can* be changed without altering the learning outcome. For example: 4 x 6 = 24 can be changed into 4 x 5 = 20. Both formulas align to the multiplication rule, the only difference are the amounts used. In essence, designers could take any number to explain multiplication as long as the amount left and right of the = are equal. Things that designers (and players) can change, manipulate, or rearrange without altering the intended knowledge construction are called restructureable elements. Depicting the restructureable elements brings designers one step closer to the design of the actual game.

One way to find the restructureable elements of a procedure is to visualize the learning content, such as by doodling a comic, or drawing out diagrams and storyboards that explain the procedure more thoroughly. Both tools may help designers to define the restructuring elements of the learning procedure. By drawing out the restructureable elements it becomes clear which elements can be played with, and which elements are fixed, since the drawn elements can possibly be rearranged or manipulated. It helps to imagine a context in which the learning content could take place. In this way designers can start defining the first mechanics of the game.

Before building the game, and digging through the learning content, consulting a domain expert may save development time. If the domain expert confirms the designer's hypothesis of the restructureable elements of the learning procedure, it is safe to assume that the design direction connects to the intended knowledge construction.

In short, designers could:

- Imagine a context in which the learning would be meaningful.

- Doodle the learning procedure.

- Consult a domain expert.

5.5 Depicting the restructureable elements

When the restructureable and fixed elements of the learning procedure are depicted, designers can transform these elements into game mechanics. The fixed mechanics set the stage of the game. They depict the main rules that the player has to adhere to. For example, in *Super Mario Bros.*, one of the main fixed mechanics is the artificial gravity in the game. Mario can jump *X*-high and *Y*-long with a speed of *Z* seconds/pixel. These cannot be changed, and they create a solid boundary to design and play in. The fixed mechanics depict the boundaries and the unchangeable rules of the game.

The restructureable elements are transformed into the play mechanics. They depict gameplay. In *Super Mario Bros.* play mechanics are found in Mario, the blocks, and foes. Players can rearrange Mario on the screen within the parameters of the fixed mechanics. Players can change question mark blocks and brick block by jumping against them. Players can manipulate foes by jumping on their heads- Koopa Troopas transform into a shell and Gumbas puff out of existence. Designers can depict which play mechanics can be changed by the player, and therefore they depict the gameplay of the game.

5.6 Develop a rapid prototype

Once the play and fixed mechanics are depicted, designers can start building their first prototype. It could save time to make a low fidelity version. This means that the designer uses a preferred method of exploring the possible engagement level and educational value of the core gameplay.

Rapid prototyping can signify design problems in early stages of development. It is therefore important to develop a rapid prototype in short feedback loops with domain experts. Typically designers can start with a paper prototype. A paper prototype involves creating rough, even hand-sketched games that are playable without the need to code something digitally (Brathwaite, 2010; Librande, 2009). The word paper may be misleading as it suggests that the game is solely made from this material. However, materials other than paper are flexible enough to simulate digital gameplay. Designers can use Lego-units, existing board-game objects, calculators, stopwatches, smartphones etc. to create a rapid prototype.
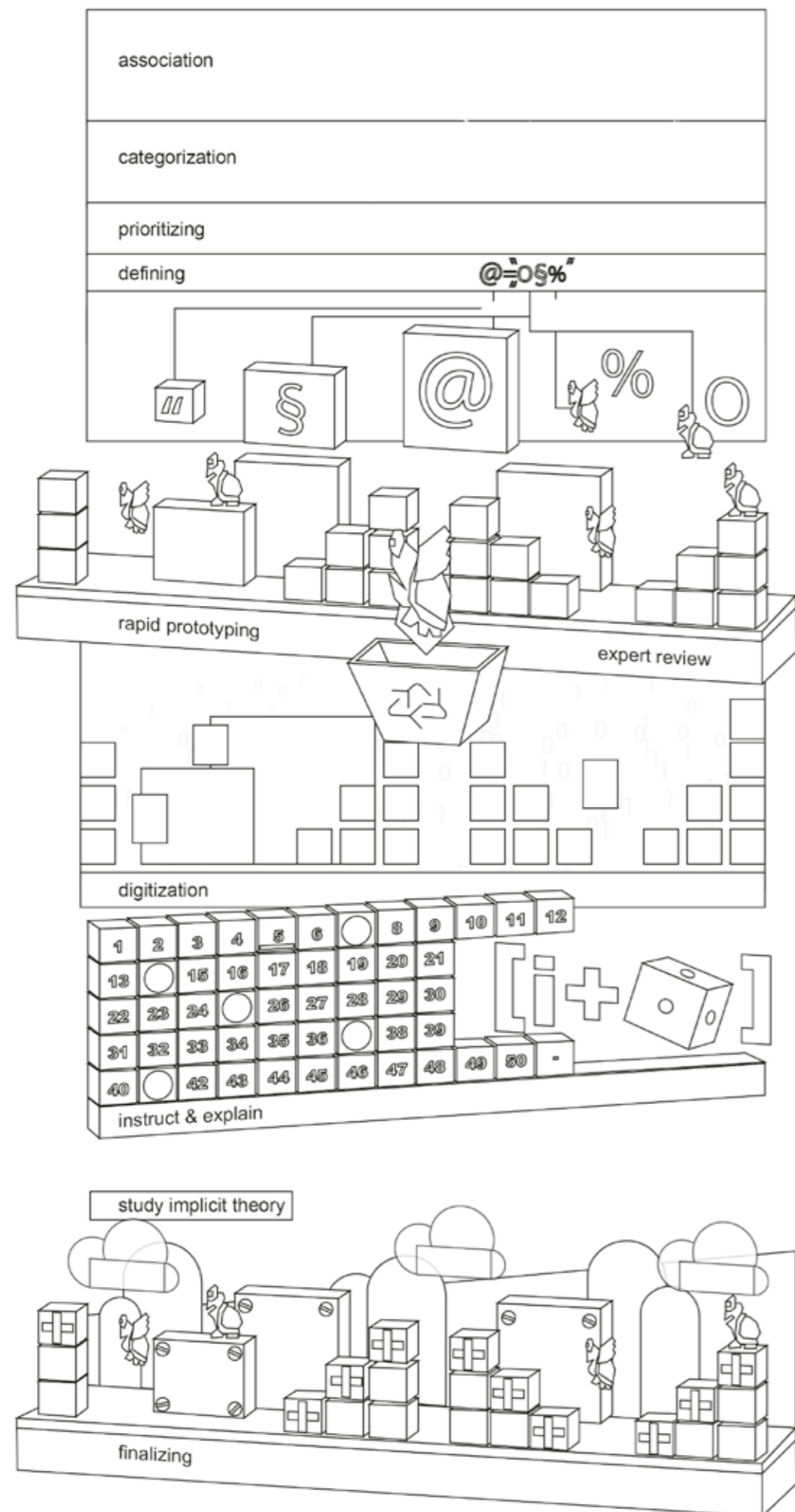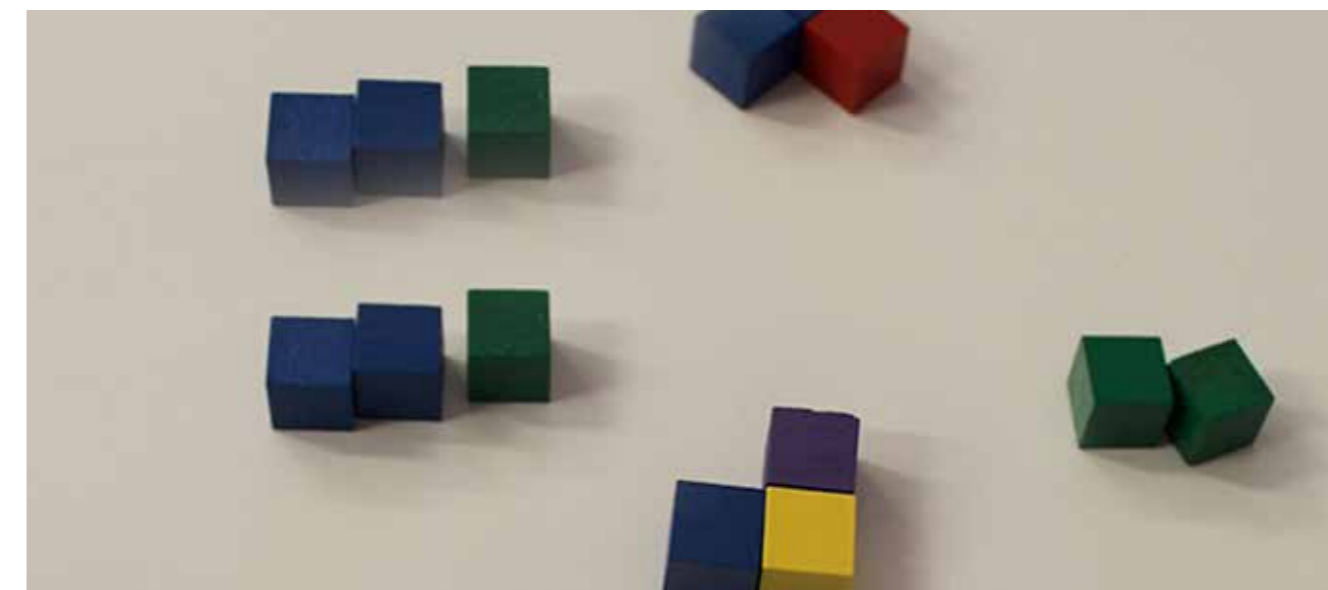
The main focus of a rapid prototype is to explore if the interaction proves engaging and whether the activity connects to the intended knowledge construction. The rapid prototype is an ideal way to explain the game to others, such as to the domain-expert. An example of a rapid prototype to explain the basic gameplay of a game on identity development can be found on http://youtu.be/I2lSiMNJL2M (*DragCube*, 2014). Merely shoving around wooden blocks, using written texts to explain the game's goals, and small drawings to illustrate a possible interaction, can be incredibly helpful when communicating about the game in early stages of development.

Librande (2009) showed how he used paper prototyping as a technique to explore various transformations and key gameplay aspects in *Spore* (Maxis, 2008). Paper prototyping helps designers to focus on the key aspects of the game and enforce simplicity in the design process that can often make the gameplay stronger. Additionally, paper prototyping can help designers to think out-of-the box and spare valuable time.

Some aspects of games are difficult to paper prototype. One of these things is the in-game economies of strategy games. It is sometimes difficult to predict what the addition of a particular resource can do to the balance of a game. To explore these issues, Dormans (2012) created a simulation program called *Machinations* (Dormans, 2009) to explore new or existing game economies. Designers can create a structure of their economy and have it run fast-forward to see the results of particular design decisions, without hardcoding them.

Some game designers with coding skills start to work immediately in constructing a digital prototype. Software packages like *GameMaker* (Overmars, 1999) and *Unity3D* (Helgason, Francis, & Ante, 2004) appear very well suited to rapidly creating a prototype and exploring whether the game is engaging and/or educational enough. In actuality there are many ways to create a rapid prototype. The most important reason to choose one particular way of doing it is to choose a way that fits the game needs and the designer's preference.

The reasons to create a rapid prototype are multifold. However, it's most important usage appears the 'sketch quality' of rapid prototypes. This can be explained with the next example. Imagine (or actually perform) drawing one perfect circle with a pen. From experience I know that a person will slowly and carefully draw a circle. Often people will sketch using a series of short strokes, creating a circle that looks a little hairy and took a minute to draw.
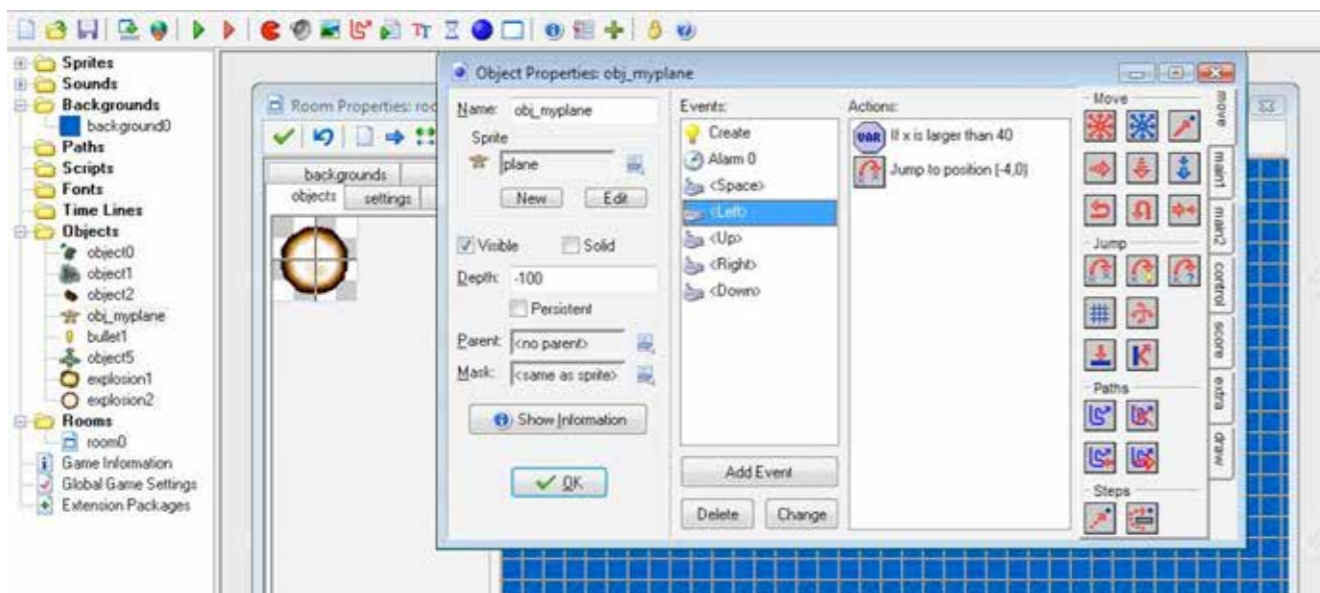
Figure 65: The 10 steps illustrated

After completing the 'hairy' circle, the individual is then asked to draw ten more circles in the same time-span as the 'hairy' circle. The drawer will end up with ten circles' of which four are well shaped, sharp and good looking. The rest of the circles are not, and can be discarded, whilst the other four could be used for elaborating further into a nice drawing.

The rapid drawing circle exercise corresponds to rapid prototyping. In the time it takes to digitally create a game, designers can create various sketches that give them more insights into the possibilities offered by the core mechanics than would a fully-fledged digital prototype. What's more, since designers put little effort into creating the games, discarding faulty work is emotionally less painful, which may improve the design decisions taken.

5.7 Consult Domain Experts

It makes sense to develop various rapid prototypes to explore different designs possibilities. Designers can run these prototypes by a domain expert to get feedback on the integration of the learning procedure in the game. Together they can depict alterations or design directions for further iterations on the prototype.

When domain experts and designers appreciate what the rapid prototype has to offer, the development of a first digital prototype starts. The aforementioned software packages *GameMaker* (Overmars, 1999) or *Unity3D* (Helgason et al., 2004) are ideal tools for digital prototyping (Vlambeer, 2011). They offer pre-defined functionalities, which can save considerable programming time. The development of a digital prototype can reveal new challenges and possibilities of the game. It will become clear that some things are easier done digitally (i.e. calculating, direct feedback, automating things) whilst others appear more difficult (i.e. tangible interfacing, collision and movement).

5.8 Prioritize what to instruct, explain and facilitate

After finishing the prototype designers can go in-depth into level progression and rule-design. In order to explain the basic gameplay to players it helps to instruct players and explain the game in a couple of short exercises. The main gameplay can be designed in accordance with the scaffolding method (section 2). By breaking down the learning and game play in easy to manage chunks of information and delivering them in a step by step fashion, designers can educate players into playing the game. Scaffolding the game's difficulty concerns two aspects:

1. Usability (how to play the game), and

2. Basic gameplay (what is the game/learning about).

Both can be educated through the practice of *instructing* and *explaining*. In light of this thesis, it may feel contradictory to model the teaching model of instructing and explaining. Especially since these controlling teaching styles may lower players' autonomous experiences. However, in consideration of the time-constraints teachers have to work with, it may be prudent to prioritize knowledge that should be learned fast, and knowledge that needs to be uncovered by students themselves.

In analogy, ball-players need to understand that a ball is round, bouncy and able to roll, before they can come up with their own game and explore the boundaries of the play-toy. In the words of an educator, students need to be able to read before they can learn to write poetry. It appears prudent to instruct and explain the basics of the game in order to save students' time. Their time can then be spent exploring, experimenting and struggling with the learning procedure. One way to do this is by scaffolding the basic gameplay and knowledge.

A rule of thumb could be: Explain and instruct the fixed mechanics and facilitate the exploration, experimentation and struggle with the restructureable mechanics.

5.9 Revisit domain expert & perform user testing

During development, the focus on the learning can shift towards gameplay. As a result, the game could become less about the learning, and designers may end up with a game with two separate entities (e.g. *Math Blaster*) or a game that does not teach the intended knowledge (e.g. the Star Trek puzzle example in section 4.5).

To uphold the Integrated Design Approach, it may help to consult domain experts and (possible) users. During these consultations, designers can check whether the game is still about the intended knowledge construction. If not, designers should iterate upon the game by returning to step 1. However, designers are warned not to throw the baby out with the bathwater, but build forth on insights and completed work until the game is really about the learning procedure of the intended knowledge construction. Usability studies can reveal various shortcomings and strengths of a game. The presence of designers and developers during usability studies may prove an effective approach to integrate user research into the development cycle of a game.

Usability studies can reveal:

- **Technical bugs**. Bugs are problems such as loading times, glitches or non-responsive controls. Programmers often fix technical bugs by optimizing the game's source code or by resolving other technical issues in the back-end.

- **Players' engagement.** Engagement can be measured in various ways, including the players' attention and action. Attention and action can be observed. For example, if players are playing and help others out, engagement can be considered normal/high. If players are not playing and talk about unrelated subjects, engagement can be considered low. Low engaged players can signify gameplay issues.

- **Gameplay issues.** Amongst others, gameplay issues concern the difficulty level of the game and understanding of the game controls.

Figure 69: Performing user-test

Figure 70: Revisiting domain expert

When a user group is found and a user test is scheduled, the presence of a designer and programmer at usability studies is highly recommended. Programmers can assist if the game fails for technical reasons. Computers and local networks on schools can frustrate the usability test. Furthermore, designers and programmers are mandatory for recognizing key gameplay issues and technical problems. Additionally, they present the researcher with an 'extra pair of eyes'. These extra eyes will prove useful in prioritizing the design decisions that the usability study elicits.

When performing a usability study, it may prove mandatory to manage players' expectations. This way, users understand what they are getting into and are better equipped to give valuable feedback. There appears to be a fine line between overstating the prototype stage of the game and suggesting that game is finished. When researchers overstate the game's prototyping phase, suggesting that there are bugs to fix, players appear to easily blame their own incomprehension to technical bugs. However understanding the development phase of the game can make students feel insecure about their ability to successfully overcome the challenges presented. What's more, if users are not asked to report bugs, they probably will not see the bugs or find them worth reporting.

Lastly, players' gameplay appears difficult to assess. Some players are verbal during play sessions. If they get stuck, they tend to report it immediately. However, other players remain silent. They play the game without drawing any attention. This does not mean that there are no gameplay issues or technical bugs to resolve. During a usability study, the extra pair of eyes (developer and designer) can 'watch' these silent types from afar. However, there is a cheaper solution to understand how users play the game.

To assess the gameplay of the 'silent type' players, it proved useful to screen-capture every play-session. The captured videos of play sessions can be analyzed by fast-forwarding the videos. Analysis of videos can be done rather fast, since observers are already knowledgeable of main issues. The video analysis appeared useful as a reflective tool to validate hypotheses made during observations. For example, we witnessed people struggling with level 26 of our math-game, and they gave up after a couple of tries. By reviewing video-captured play-sessions of other players, we confirmed that the levels were too difficult. In response, the level was changed in the next iteration.

6

5.10 Iterate upon feedback and finish the game

User studies apeared valuable in regard to finishing and polishing the game. Depending on development time, it is suggested to perform at least one user test to make final iterations on the product.

In summary, the first part of a game design that adheres to the Integrated Design Approach can follow the following design process. Define the learning as a procedure. Declare the restructureable & fixed elements of the learning procedure. The fixed elements form the game's stage, they declare the main rules that players have to adhere to. The restructureable elements are the objects, rules and environments that can be changed, manipulated or rearranged. They constitute for the playful elements in the game and signify the dynamics of the game. Create a rapid prototype wherein player can rearrange the restructureable elements in a meaningful way.

Prioritize in what to instruct (compliant), explain (overbearing) and facilitate (autonomy-supportive). Scaffold the restructuring opportunities and learning possibilities. Present the game to domain experts and (possible) users to check if the game is still about the learning. Iterate upon the feedback received. Perform in actual user tests to determine technical bugs, engagement and gameplay issues. Reflect upon these play sessions and contribute the findings to the last iterations of the game.

Figure 71: Presenting the first digital prototype to domain experts (Combinatorics version 1.0 at VOR ICT gathering in 2011)

CASE STUDY
COMBINATORICS

Parts of this section are based on:

- Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven: Leuven University.

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches.* IGI Global.

- Deen, M., & Schouten, B. A. M. (2014). The differences between Problem-Based and Drill & Practice games on motivations to learn. Presented at the International Academic Conference on Meaningful Play, East Lansing.

SECTION 6 **CASE STUDY** *COMBINATORICS*

To illustrate how the steps of section 5 apply in the context of an actual design process, this section describes the development process of *Combinatorics* (Deen & Verhoeven, 2011). We chose to make a game for mathematics for various reasons. From a practical standpoint, a domain expert on the subject was readily available at Fontys ICT. Working with this expert would save time and anchor design decisions.

From a theoretical standpoint, many serious games have been developed for mathematics. However, they seldom offer an autonomy-supportive learning environment. Games like *Math Gran Prix* (Atari Inc., 1982), *Math Blaster* (Davidson & Associates, 1994), *Monkey Tales: Monkey Labs* (Larian Studios, 2009), *Eedu Elemements* (SkillPixels, 2013) and *Motion Math Zoom* (*Motion Math: Zoom*, 2013), adopt the instructional model of the explainer and instructor, focusing on skill mastery and correct performances.

Autonomy-supportive games that facilitate the experimentation, exploration, and struggle with a mathematical problem are far and few to be found. In contrast, it appears easier to find autonomy-supportive games for educational subjects like history, geography, economics and literacy. Most of these appear inspired by the thoughts brought forward by Shaffer (2008); creating a simulation like game in which players are invited to adopt a particular epistemic framework, and explore how this perspective on a complex problem incites particular decisions.

While browsing through the course book *Getal & Ruimte* (Number & Spaces) (Reichard et al., 2003), we stumbled upon a chapter called 'Smart Counting'. I remembered that I did not enjoy this exercise back in high school. In the course book, smart counting is placed in the context of dinner menus, holidays and traveling routes. Students are asked to calculate how many variations there are in a menu, a travel brochure and a particular road map. In short, I could not care less. I could not understand why it mattered and I did not understand the underlying mathematic of the problem. We surmised that designing a game for this chapter would be the best possible challenge for a game designer: i.e. turn something tedious into something engaging and maybe even fun.

6.1 The learning goal and procedure

In mathematics, the notion of permutation relates to the act of permuting, or rearranging, members of a set into a particular sequence or order (unlike combinations, which are selections that disregard order). For example, there are six permutations of the set {1,2,3}, namely (1,2,3), (1,3,2), (2,1,3), (2,3,1), (3,1,2), and (3,2,1). As another example, an anagram of a word, all of whose letters are different, is a permutation of its letters. The study of permutations of finite sets is a topic in the field of combinatorics. ("Permutation," 2014)

The chapter 'Smart Counting' in *Numbers and Space* (Reichard et al., 2003) deals with various aspects of permutations in mathematics. As a designer, I completed the chapter's exercises and consulted a domain expert to figure out what the main learning goals and the overarching learning procedure would be. Together we depicted the so-called: And&Or-Rule. Basically the And&Or-Rule depicts if students should summarize or multiply when calculating all possibilities of a specific combination.

The And&Or-Rule is frequently applied in the gambling industry as a prelude to calculating chance. To understand how much chance gamblers have to win the slot machine's jackpot (for example, a combination of 7, 7, and 7), a person must first count all possible combinations. In the course book: *Numbers & Spaces* (Reichard et al., 2003), Reichard and colleagues explain the calculation of combinations with the metaphor of 'roadmaps and routes' to explain combinatorics. One roadmap can offer various routes to travel from one point to another. Imagine that people wish to travel from A to D (via B and C) (see Figure 72). They can take four routes to get from A to B, *and* three routes from B to C, *and* two routes from C to D. By result, there are four, *and* three, *and* two routes from A to D. The amount of routes may be multiplied to calculate the amount of all possible routes from A to D: Thus, 4 x 3 x 2 = 24 routes.

However, in some roadmaps, a shortcut from A to C is given (see Figure 73). A person can travel by (3 x 2 =) six routes *or* by one shortcut. To calculate the amount of possible routes, the sum of available routes is taken. There are (3 x 2 + 1 =) 7 routes from A to C. As such, the main rule of calculating combinations is: *and* is multiplying and *or* is summation.

Figure 72: Roadmap with And-Rule: 4 x 3 x 2 = 24 routes

Figure 73: Roadmap with And&Or-Rule: 3 x 2 +1 = 7 routes

6.2 Depicting the restructureable elements

Now that the learning goal and its procedure are depicted, we needed to figure out which of the learning elements are fixed, and which are restructureable. To do this, designers can imagine a context in which the learning would be most meaningful to the learner. The course-book *Numbers & Spaces* (Reichard et al., 2003) proved unhelpful. It presented various contexts in which the rapid calculation of possibilities can be meaningful. However, none of them felt meaningful to me. For example, one context used by Reichard et al. is the amount of possible ferries in-between Greek islands. This example felt a little far-fetched. Why would travelers want to calculate all possibilities? They would not travel them all anyway?

When will calculating possibilities be meaningful? Or in other words, when does the quantity of exponential growth matter (other than gambling)? After some scribbling, cell division in biology came to mind. The growth of an organism coincides with the amount of cell divisions. Cells can divide into two, three or more cells, depending of a range of variables. Understanding how many and what kind of divisions are made, gives insight into the organism's growth, and would therefore be a meaningful exercise.

Now the context was set, the learning procedure was sketched within the context of cell division: As an imaginary cell travels through a body, at a certain point it would travel through an intersection, and there cell splits into the amount of branches. Every newly formed cell travels further until it stumbles upon a new intersection. At the end of its journey, the cell has divided an *x* number of times, illustrating the amount of possible routes in the body.

With the doodles in place, a domain expert with a PhD in mathematics was consulted. The domain expert concluded that the above metaphor explained the And&Or-rule well. Consequently, the restructureable elements and fixed elements of the learning-procedure were defined.

The restructureable elements are:

· Roads.

· Intersections.

· Possible outcomes (if this changes the roadmap changes too).

· Amount of cells (at the start).

· The movement of the cell.

The fixed elements are

· The *And&Or-Rule*.

· The division of the cell (which adheres to the *And&Or-rule*).

The *And&Or-rule* could not be changed or manipulated by the player. The cell divided in accordance to the number of intersections, and could therefore not be changed by the player. What could be restructured was the road the cell traveled though. Restructuring the roadmap on which a cell travels became the main dynamic of game. This initiated step 2 of the development process: Developing a rudimentary prototype.

6.3 Rapid prototyping Combinatorics

For the first prototype of *Combinatorics* we simulated the restructuring of roadmaps by drawing on a whiteboard. It appeared engaging to wipe existing routes and replace them with others. For *Combinatorics* paper-squares were cut out that contained a crossroad, a straight road, a ninety-degree corner and a 3-way junction. With these road-tiles a vast variety of roadmaps could be created. Also, existing roadmaps were easily restructured (i.e., played with).

The prototype showed that playing with exiting roadmaps had an engaging quality. Now the game had to explain the *And&Or-rule*. This meant that some aspects of the game needed an instructing or explanatory quality. For the next step, prioritizing what to instruct, explain and facilitate, possible constrictive activities were explored.

The search for constricting/steering gameplay gave birth to the idea of limiting the amount of tiles to players. By limiting the amount of road-tiles, only one roadmap fits the targeted amount of possibilities. This appeared a necessary step to explain the *And&Or-rule*.

The paper prototype was presented to the aforementioned domain expert. The expert was asked if the game was still about the intended learning procedure and whether the game was engaging. Additionally, students of Fontys School of ICT – Game Design & Technology were invited to develop the game. Three students complied, and started to work on a digital prototype.
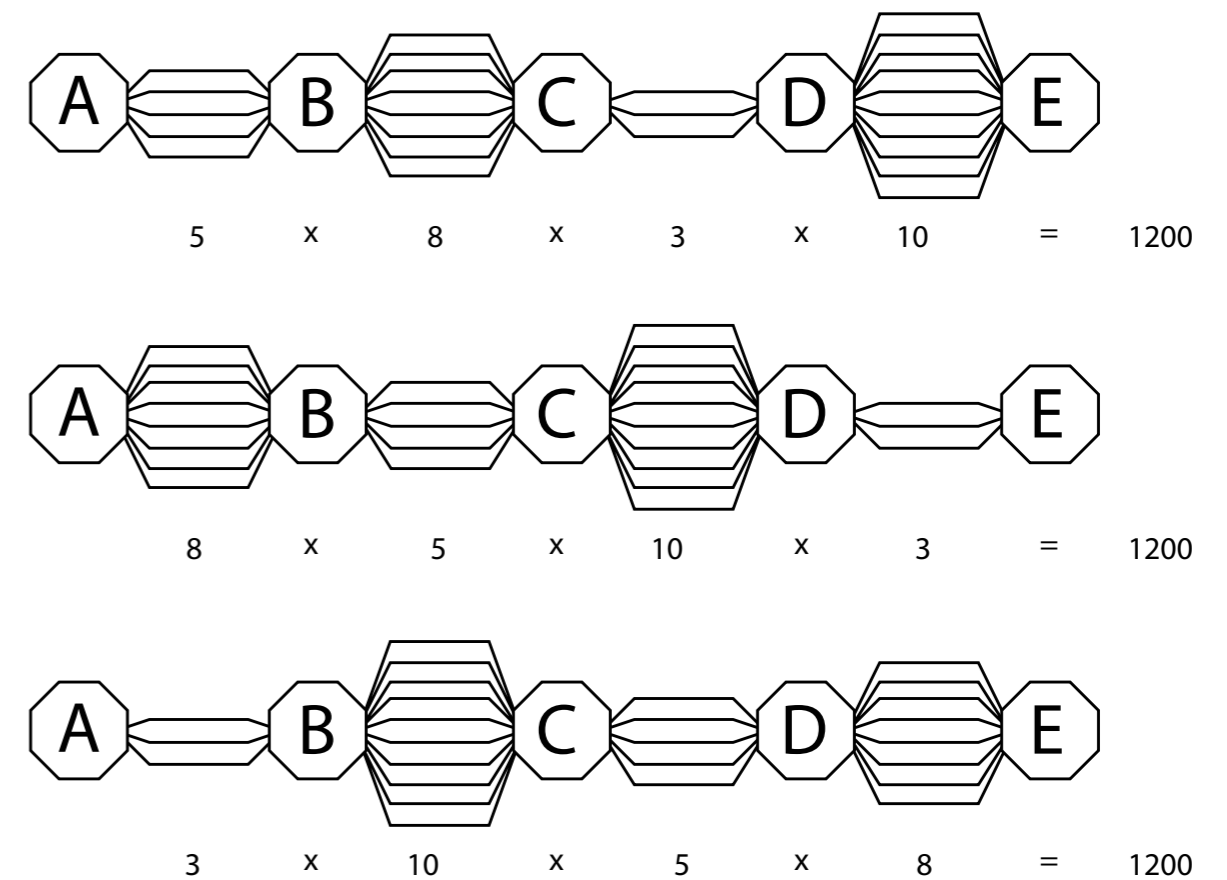
6.4 Develop a digital prototype

Combinatorics was designed in accordance to the scaffolding-style of the course-book *Numbers and Spaces* by Reichard et al. (2003). In order to get a better understanding of the book's didactic approach, I revisited the exercises of the chapter 'Smart Counting' to discover that the [i + 1] rule (see section 3.4) was already adhered to in the course book. The chapter gradually introduced new insights to students and incrementally builds towards more complex problems.

Some exercises in the book could not be translated directly to the game; they were in need of alteration. For example, in one of the course-book exercises students have to calculate the same amount of routes in different configurations:

$5 \times 8 \times 3 \times 10 = 1200$

$8 \times 5 \times 10 \times 3 = 1200$

$3 \times 10 \times 8 \times 5 = 1200$

This exercise teaches students that the configuration of routes does not matter as long as the route-sets can be multiplied (see Figure 74).While translating the above exercise to the road-tile representation of *Combinatorics*, we stumbled upon a problem. The game's grid is only nine by twelve tile large. As a result, there was not enough room on the screen to create a roadmap with 1200 routes (which were used in the book's example (see Figure 75). Moreover, it became rather difficult to count the amount of routes in this representation.
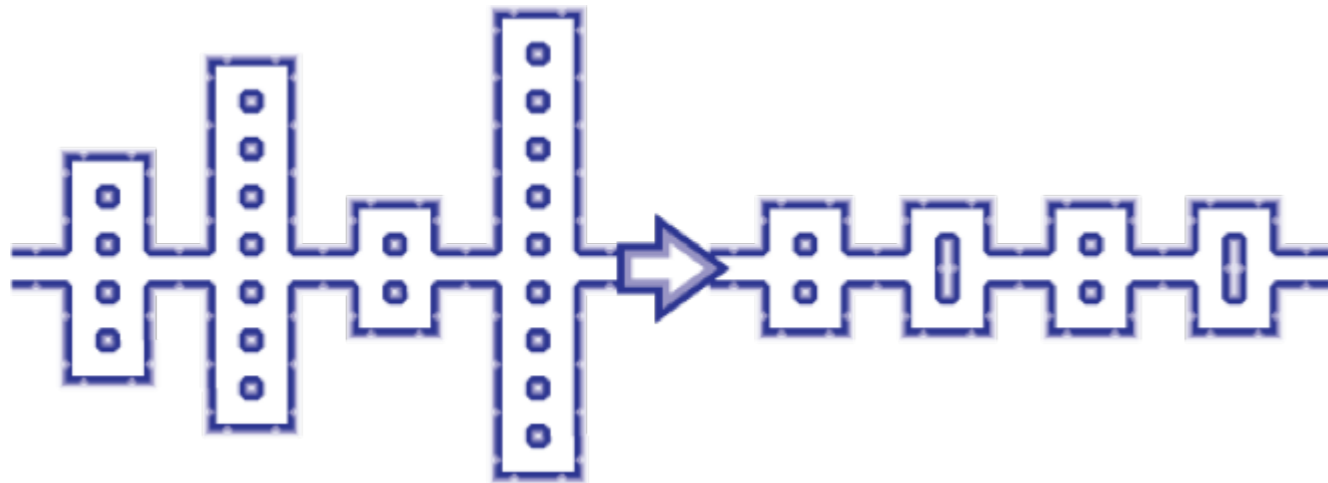
The *number* of possibilities does not influence the learning activity. Explaining that 'different configurations can have equal possibilities' is not subjected to the numbers used (4, 8, 3, and 10). The high numbers of the original course-book exercise (5 x 8 x 3 x 10) could easily be decreased without changing the learning procedure of the intended knowledge construction. The numbers of routes are restructureable elements of the learning procedure. That is why levels 5, 6, and 7 ask players to solve configurations like: (2 x 3 x 2 x 3), (2 x 3 x 3 x 2), and (2 x 3 x 3 x …) (see Figure 74).

As said, explaining and instructing concerns usability issues as well. Simply put, the basic gameplay needs to be educated. The interaction with the game could not be 'copied' from the course book, since the media (book vs. game) differ. Instead, user observations of the first prototypes guided the [i + 1] design of gameplay. Students of Fontys College of ICT – Game Design & Technology played the prototype. We focused on player's understanding of basic interface issues and assisted players when they asked for help.

We used the following rule of thumb: for every action that was in need of explanation we designed a level. For example, we witnessed that players were searching for the tiles. They asked "Where can I find that tile?". As a result, a level was created to explain every tile's position. To explain the gameplay step-by-step the first levels introduced a new action in the game. As a result, level 1 instructs players to pick-up a tile and to place it on an empty spot. Level 2 introduces corners. Level 3 introduces the possibility to turn a tile, etc.

Scaffolding the gameplay difficulty concerns both the learning as the usability of the game. Course-books or other existing learning methods can be used as blueprint for the didactic approach, while user testing can guide design decisions for usability and gameplay.

6.5 Usability test and iterations

A usability test amongst 15 to 16 years old students (n = 25) at the *Novalis College* in Eindhoven exposed various design issues. For one, the game's learning curve of basic functionality appeared well designed. Students had little trouble in accomplishing the challenges. Within ten minutes students were either playing or helping others.

The higher levels, however, were in need of alteration. Instead of struggling with the And&OrRule, students were struggling with the roadmap itself (see Figure 77 and Figure 78). Additionally, some gameplay elements eluded players. Some players had difficulty in finding particular road-tiles, or deducing the And&OrRule. The findings resulted in more feedback on 'how to play', various changes in level design, and more feedback on the mathematical construct itself.

The usability study at the *Novalis College* revealed various technical bugs, gave insight into the engagement level of players, and uncovered some gameplay issues.

Bugs
The game suffered from loading-time issues. That is because we used an adhoc network and had players play the game on a server. This way, we did not have to install the game on all 25 laptops. However, the network-play resulted in delays in loading time of new levels.

Another technical bug related to the game's way of counting the amount of possible routes. When players complete a roadmap, a small animation plays. A green dot travels through the newly constructed roadmap. At every intersection, the dot multiplies in accordance to the amount of branches. As a result, the dot multiplies by two at a 3-way junction and by three at an intersection. If the number of dots equals the level's target number the puzzle is solved. Players could intervene in this animation. They could close a road during the counting process, fooling the system that they created enough routes.

Engagement
The attention and action of players could be observed in various ways. We chose two options: observations and measuring time-on-task.
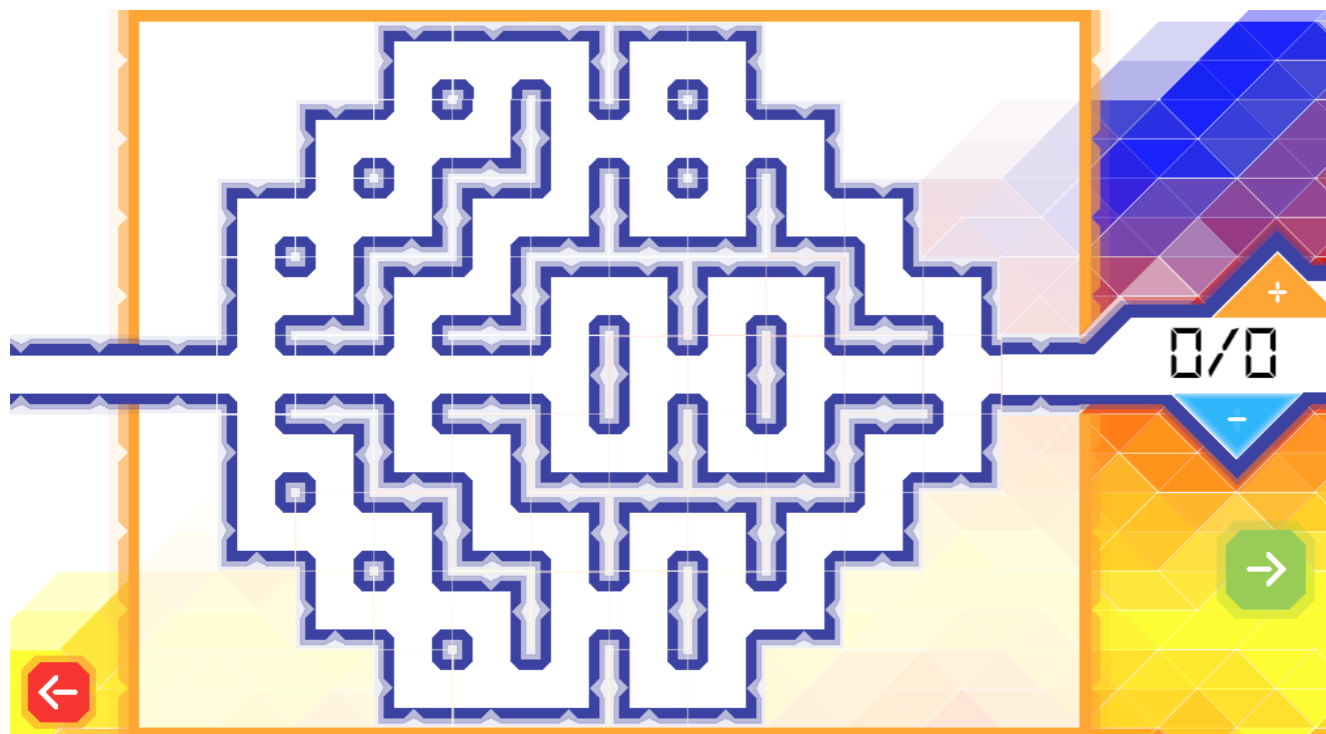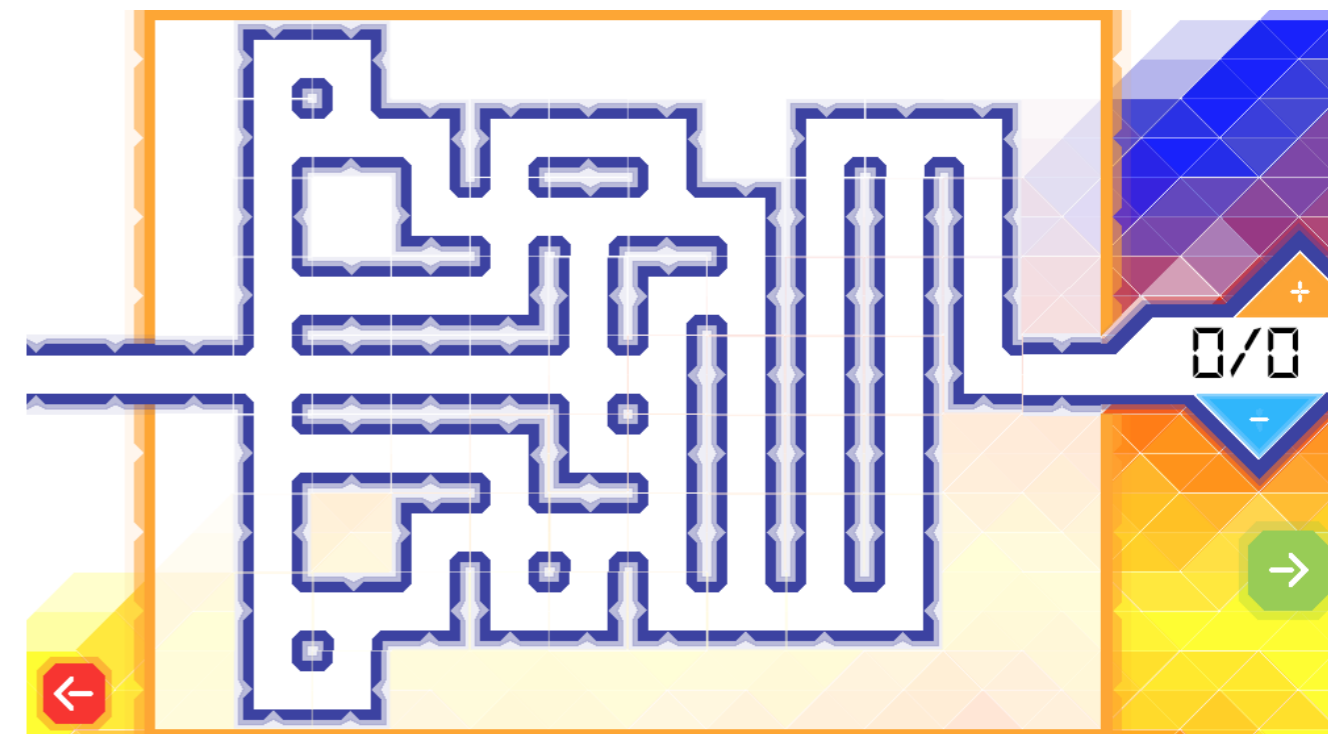
Four students of Fontys ICT performed observations during the play session. All four were software engineers and were asked to look specifically for technical and gameplay bugs. Additionally, they were asked to take notes when players appeared bored with the game.

Players were considered to be bored when they did not engage with the game and either conversed with other students about unrelated topics or aimlessly stared at the screen. Since the interest of this thesis in engagement mainly concerns motivation to learn before and after playing the game, we did not perform elaborate studies towards engagement during play. Therefore we mainly noticed the clear signifiers of non-engagement and wrote down in which level players were playing. It turns out that, especially for the last levels in the prototype, players stopped playing, suggesting that their engagement reduced because these levels were simply too difficult.

Time-on-task was measured by asking students to write down the time of completion. When players finished the game they wrote the time on the instruction leaflet and waited for the others to finish too. It took students approximately 25 minutes to finish the game or stop playing.

Gameplay
The difficulty growth issue found in higher levels was revealed in our usability test. The test revealed more gameplay issues and brought up several solutions for the technical bugs as well. Amongst others, gameplay issues concerned 1) the end-levels' difficulty, 2) cultural differences between groups, 3) the self-imposition of rules and 4) text reading.

1. The issues concerning the end-levels' difficulty were attended to after the first user test. The level design was altered in such a way that it was easier to 'read' the roadmaps. For the greater part, the amount of possibilities had to be trimmed down until it fitted the game's interface.

2. Different groups of students have different cultures. Although we designed a game to be autonomy-supportive, other forms of play emerged naturally from player-groups themselves. Most noticeable was the emergence of competitive play and restrictive gameplay. For example, VWO-4 students (preparing for university studies) appeared rather competitive during play. Remarks such as "Are you just at level 4? I'm already at 8!" and insults relating to one's intellectual capacities "Tssss you're soooo dumb." and "You're stupid, didn't you get that?" were commonplace. In contrast, HAVO-4 (preparing for a college level study) appeared to help each other out, blamed the game for being incomprehensible or too difficult, and cheated more.

3. As mentioned, cheating was possible by changing the roadmap during the counting process. However, players tended to replay cheated levels 'in the right way'. Another example of self-imposed rules is the self-enforcement of mental calculations. Although the use of a calculator was allowed, students calculated various equations mentally until it became too difficult. At this point, they consulted a digital calculator. A fifteen-year-old boy reported casually "This is good for my calculation skills."

4. Lastly, we found that players got stuck on a level but never read the explanatory text in the 'game over' screen. As loading times of levels were too long, it was decided to add instructive texts to the loading screens. Before the level started, players are primed with a small sentence that instructs, hints or jokes about the upcoming challenge. During second tests, this proved a valuable approach as questions about the game decreased after implementing them.

As mentioned, it proved valuable to invite designers and programmers to the usability test and to assign them roles to focus on specific aspects of the experience. These extra eyes can be presented with a block-note and asked to note gameplay issues, technical bugs, and players' engagement. After the usability study, findings can be discussed and a plan for new alterations can be constructed.
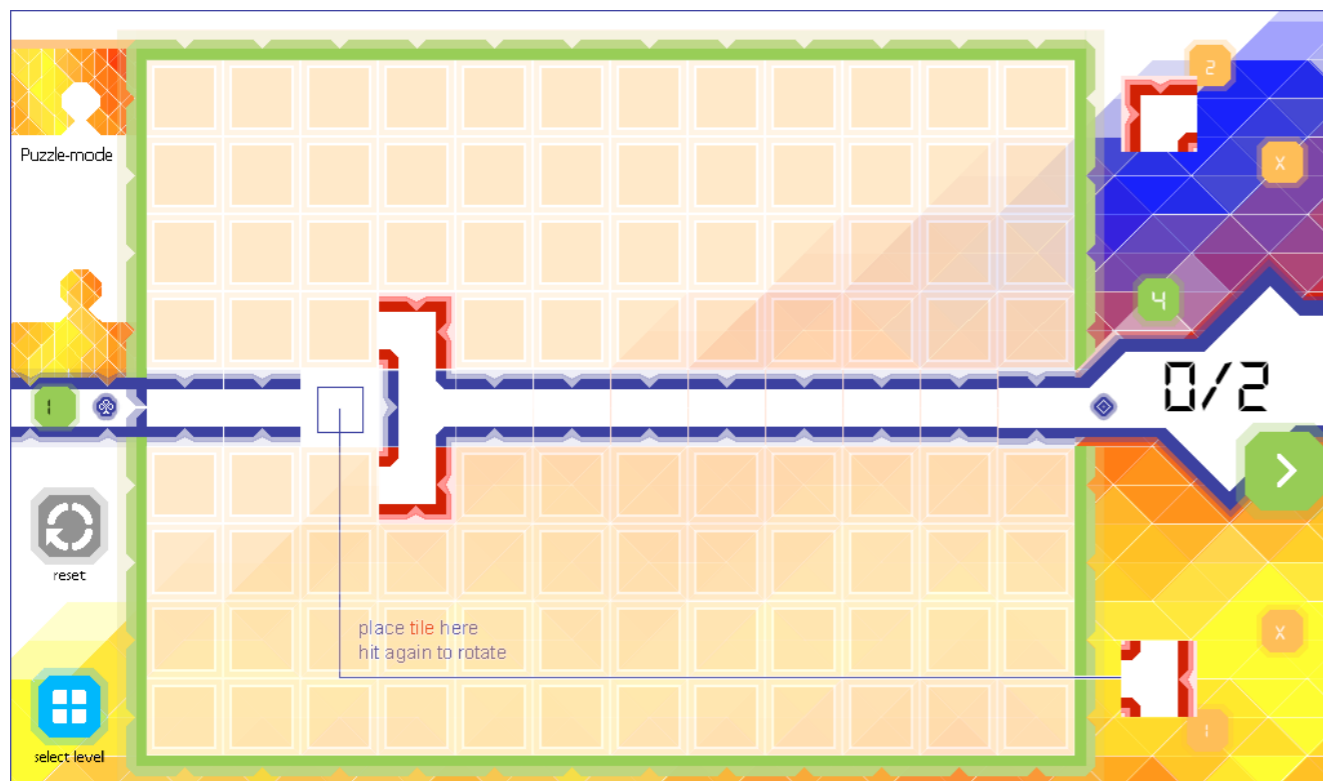
After the usability study of *Combinatorics*, the ability to cheat during the counting phase was discussed at length amongst designers, programmers and researchers. It was decided to keep the exploit in the game. For one, fixing the bug would take considerable time, which was better spent on improving the difficulty growth of the game. Secondly, because of the self-imposition of rules by students, it seemed a waste of resources to work on this bug. On top of that, self-expressive players might enjoy this little bug, since it offers them a way to work around the game's rules. Interpersonal players might also enjoy the bug, since encountering the bug elicited social negotiations about it, and more interestingly about the way the puzzle should be resolved.

Finalize the game
The user tests, feedback of domain experts, and personal play-throughs were used to make the final adjustments to the game. The game was uploaded to a server and could be played on a website in a browser. The design process complies with the 10 steps of section 5. As a result we integrated the learning with the gameplay and created an autonomy-supportive game in which players can restructure various aspects of the mathematical challenge and are instructed in the basics of the learning procedure.

The next section will revisit the design steps and brings forth a design model for applied/serious game design. This is part 1 of the guidelines. It deals with the translation of learning into a game. Part 2 in section 8 will add motivational features to the model. The next section will summarize section 5 and 6 in the Applied Game Design Model.

7

THE APPLIED GAME DESIGN MODEL

Parts of this section are based on:

- Chatham, A., Schouten, B. A. M., Toprak, C., Mueller, F., Deen, M., Bernhaupt, R., … Pijnappel, S. (2013). Game jam. In *CHI '13 Extended Abstracts on Human Factors in Computing Systems* (pp. 3175–3178).

- Deen, M., Cercos, R., Chatman, A., Naseem, A., Bernhaupt, R., Fowler, A., … Mueller, F. (2014). Game jam: [4 research] (pp. 25–28). ACM Press.

- Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven: Leuven University.

- Deen, M., & Schouten, B. A. M. (2014). The differences between Problem-Based and Drill & Practice games on motivations to learn. Presented at the International Academic Conference on Meaningful Play, East Lansing.

SECTION 7 **DESIGN MODEL**

Games are the formal equivalent of […] processes, stripped of most incidental details. Reducing large-scale [...] processes to [...] games exposes their essential dynamics with a lucidity and drama unequaled by other teaching techniques. (Abt, 1971, p. 21)

As far back as 1971, Clark C. Abt described the serious games of today. His perspective on games with educational purposes has greatly influenced the direction and conclusion of this thesis. Abt states that a game is an "Activity amongst two or more independent decision–makers seeking to achieve their objective in a limiting context." (1971, p. 6). In serious games this limiting context is the learning content. In order to design a game that corresponds to this learning content, the content needs to be stripped of most incidental details.

The learning content of *Combinatorics* was at first a rather fuzzy concept of 'calculating change'. This fuzzy concept was refined to the activity of 'smart counting'. Calculating change was stripped of its most incidental details, creating a clear learning goal for the game to be designed for. However, since gaming is an activity, the learning should be characterized as such. Bogost (2007) already paved the way with this transition. Bogost suggested that the learning content could be defined as a procedure. Bogost defines a procedure as a rule-based representation of something and it describes possible interactions within these rules.

The basic rule of 'smart counting' is the And&Or-Rule. Calculating combinations upholds the rule that *and* is multiplying and *or* is summation. In contribution to Abt and Bogost, section 4.4 suggested that this learning procedure consists of restructureable and fixed elements. The fixed elements are the parts of the learning procedure that cannot be changed without changing the 'truth' behind the procedure. For *Combinatorics* the elements that are unchangeable is the And&Or-Rule, and the amount of combinations that roadmaps can offer.
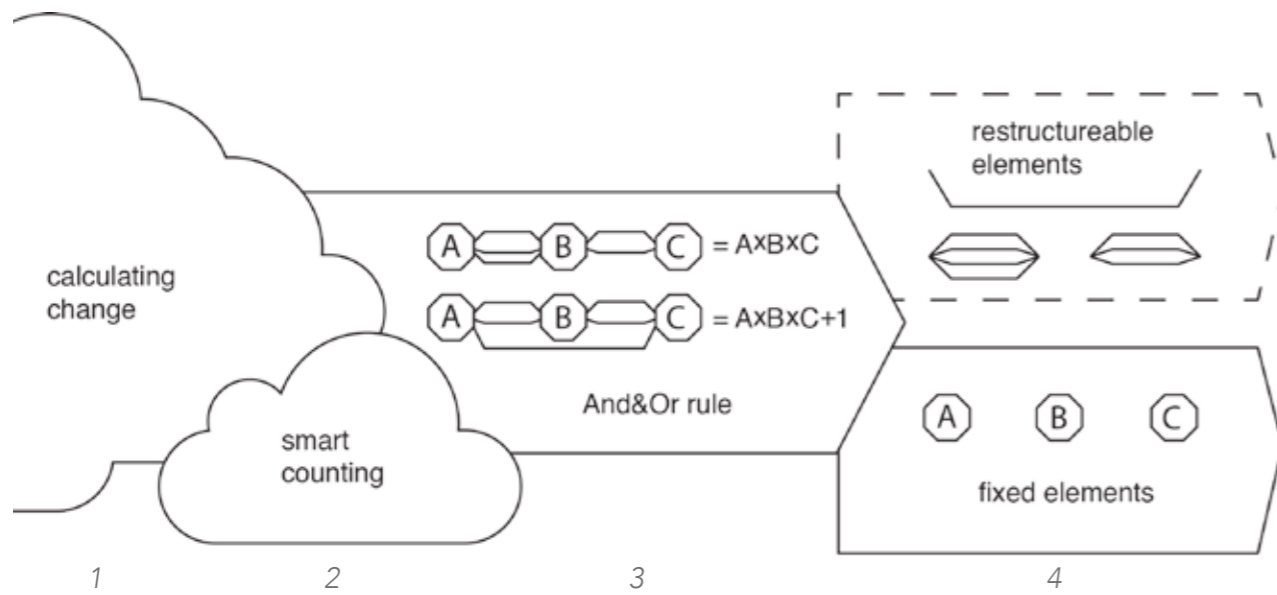
Figure 80: Clarck C. Abt's book was highly influenced this thesis

By defining the parts of the learning procedure that can be changed, manipulated or rearranged, designers practically define the playful mechanics of the game. For example, in *Combinatorics* the restructureable elements consist of the pathways; the corners, straight lines and intersections. Students can change them without altering the And&Or-Rule. Thus, the learning content remained intact, even though players changed or manipulated parts of the learning procedure.

If Icheb from the Star Trek example in section 4.5 would have refined the fuzzy learning content of genetics to the procedure that signified the interactions of complementary base pairs, and consequently had defined the restructureable and fixed elements of this particular aspect of genetics, he might not have made a jigsaw puzzle about visual correspondences. Instead, he might have come up with a holographic representation of base pairs and their relations on the Holodeck. In it, Icheb might have presented Naomi the opportunity to restructure (i.e. play with) the relations between the base pairs, and witness the results of her actions.

This imaginary game would probably resemble the gameplay of Foldit (University of Washington, 2008), which is a game about protein folding. Instead of creating a constricting puzzle game about visual correspondences, Icheb might have created an autonomy-supportive game that would allow Naomi to explore, experiment and struggle with the learning content and find the truth behind the complementary base pairs by herself.

In Figure 81 the refinement of a fuzzy learning concept is illustrated. The process is cut into 4 parts:

1) Start with a fuzzy learning concept (illustrated with a large cloud).

2) Refine the fuzzy cloud to a clear learning goal; strip off the most incidental details of the cloud (illustrated with a smaller cloud).

3) Define the learning procedure (illustrated with an arrow like rectangle).

4) Determine the restructureable and fixed elements of the learning procedure (illustrated with two rectangles: The lower-right solid rectangle signifies the fixed elements, the upper-right dashed rectangle signifies the restructureable elements).
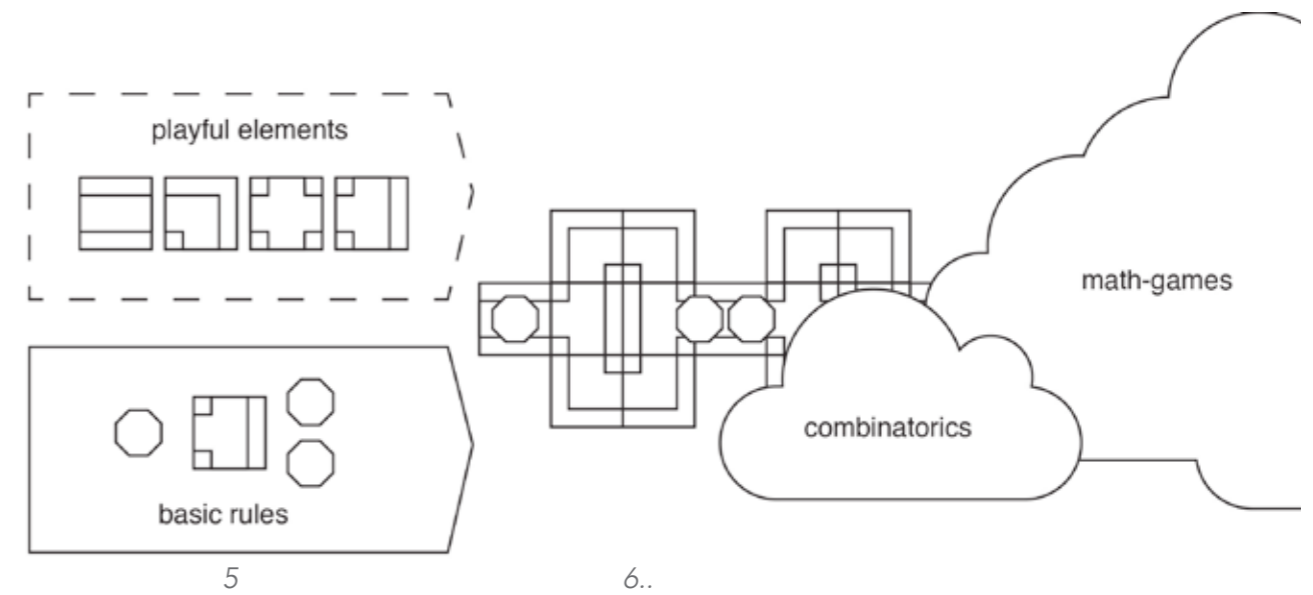
In the second phase of the *Model of Applied Game Design* the restructureable and fixed elements are transformed into game elements. The fixed elements depict the basic rules of the game. They 'set the stage' so to speak; defining in between which boundaries play can occur. The basic game rule is that 'the cell' always divides in correspondence to the amount of intersections stumbled upon.

The restructureable elements constitute for the playful artifacts in the game. In *Combinatorics* the restructureable elements of the learning procedure were translated to road-tiles of corners, straight roads, three-way intersections and cross-roads. Additionally, designers (or players) can play with the targeted number of routes.

When these elements are defined and translated, designers can create a game. Designers can conform to the five steps of sections 5, placing high emphasis on the input from domain experts and users. The final version of *Combinatorics* came into being through a design process of three iteration cycles in which the game was user tested twice.

When the game is developed it can become part of a larger game or curriculum. Hereby it can be integrated in the fuzzy learning content that was defined at the start of the design process (see Figure 82).

In clearly defined steps:

5) Transform the restructureable elements to changeable game mechanics and the fixed elements to unchangeable mechanics (doodle, sketch).

6) Develop a prototype (create a digital or paper prototype).

7) Consult domain experts (experts in the field).

8) Prioritize what to instruct and what to facilitate.

9) Revisit domain experts and perform user tests.

10) Iterate upon feedback and finish the game.

8

This section showed how designers can adhere to the Integrated Design Approach as proposed by Habgood (2007) and inspired by the work of Abt (1971). It must be noted that this is only one of the many ways to avoid the design of serious games in which games are embellished with learning content, or in which learning is embellished with game elements, or where designers create two separates entities, or (lastly) where designers create a mismatch between knowledge construction and gameplay. Instead, the ten steps described above may help designers to create games in which players actually play with the learning content. Key to this process is approaching gameplay as a restructuring process.

In order to find the restructurable elements of the learning content it helps to break the learning content down to its qualites by visualizing the learning content in a different context, or making the qualities explitit and tangible by assigning real objects (blocks, papers, pions etc.) to the qualities. When the break-down is completed, depict which elements can be altered, rearanged or manipulated without changing the intended message or knowledge construction. In short, find what can be changed in the learning content without changing the intended knowledge construction and the game emerges naturally.

MOTIVATION
SATSIFYING NEEDS FOR AUTONOMY

Parts of this section are based on:

- Deen, M. (2009). Onderzoeksrapport validatie CheckOut! Ranj Serious Games & ROC West-Brabant.

- Deen, M., Cercos, R., Chatman, A., Naseem, A., Bernhaupt, R., Fowler, A., … Mueller, F. (2014). Game jam: [4 research] (pp. 25–28). ACM Press.

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches.* IGI Global.

- Deen, M., & Schouten, B. A. M. (2014). The differences between Problem-Based and Drill & Practice games on motivations to learn. Presented at the International Academic Conference on Meaningful Play, East Lansing.

SECTION 8 **MOTIVATION**

People do things for a variety of reasons and they engage in activities with different intensities of effort. Understanding what makes people 'tick' is one of the main reasons to study human motivation. This section depicts the theoretical framework of this thesis on human motivation. Since most serious games appear to be designed to engage learners in what would normally be less motivating exercises, it appears prudent to get a firm understanding on the psychology underlying this process.

Over the years, scholars have brought forward a large body of research on our 'willingness or desire to engage in a task' (Garris, Ahlers, & Driskell, 2002, p. 451), and on our choice to engage in an activity and the intensity of our effort expended on that activity. Some suggest that motivation can be derived from our environment (Heckhausen, 1967), while others suggest that motivation originates from within people (M. R Lepper, Corpus, & Iyengar, 2005; Mark R. Lepper & Greene, 1973).

Many studies examined game features that induce motivations amongst players (Csikszentmihalyi, 2002; Dickey, 2005; Garris et al., 2002; Habgood et al., 2005; Malone, 1981; Przybylski et al., 2010; Rigby & Ryan, 2011; Yee, 2006), and these reaffirm the belief that games can be highly engaging *and* motivate players to invest time and effort into playing the game. This thesis focuses mainly on understanding players' *willingness* to engage and less on the intensity of effort put into the engagements.

Motivation can be considered intrinsic and extrinsic to an individual. Intrinsic motivation emanates from within an in individual, whilst extrinsic motivation originates from outside the individual. According to Rigby, Deci, Patrick & Ryan (1992) theorists on motivation have accepted the idea that living beings are by nature actively assimilatory. These theoritsts appear to appreciate the idea of intrinsically motivated learning. Which means that humans are motivated from 'within' to learn.

It is suggested that this inherent process of learning provides us with motives for highly effective methods of learning. Rigby et al. suggest that theorists like Dewey (1910, 1997) and Piaget (in Jennings, 1967) hold the belief that these intrinsic motivations represent our greatest human resource. It may prove valuable to connect to these intrinsic motivations when designing a game for learning, since this may be a more 'natural way of learning' (Rigby et al., 1992, p. 167).

Figure 83: Motivation illustrated

Extrinsic motivation positions the self-initiating engagements of intrinsic regulations in a dichotomous relationship with conditioning or programming engagements. This means that intrinsic motivations (engagements that originate from within individuals) contrast with extrinsic motivation (engagement that originates from outside individuals). This suggests that extrinsic motivations come from 'outside' the individual and are induced by our environment. Bandura (1997) claims that we change our motives and behaviors in accordance to our surroundings. It suggests that we adapt our willingness and desires to the possibilities presented by our environment.

DeCharms (1968) describes how intrinsic motivation involves an internally perceived locus of causality. In other words, intrinsic motivation concerns individuals' sense of autonomy, of being self-determined and self-legislated. In comparison, extrinsic motivation involves an externally perceived locus of causality. In other words, external motivation concerns heteronomy, being subordinated or subjected to (external) others.

From an educational perspective, and taking into regard the confined environments of games, this thesis positions itself in-between this apparent dichotomous relation of intrinsic and extrinsic motivation. If designers wish to appeal to players' intrinsic motivations they have to change the game environment to do so. As a result, players are influenced by the external environment and thus, partly extrinsically motivated to play.

On the other hand, by appealing to players' intrinsic motivations, players may feel that their desires are met by the game, and will therefore engage in the game. These players are therefore, intrinsically and extrinsically motivated to play.

According to Deci, Eghrari, Patrick & Leone (1994) extrinsic motivation can be internalized to the individuals self if particular needs are satisfied. This means that individuals brought external demands or opportunities in congruence with their personal selves and become intrinsically motivated to act. What these needs are, and how they can be called upon in game design will be discussed in this section.

This section discusses *how* designers can appeal to *which* intrinsic needs in autonomy-supportive games. The way designers can appeal to universal human needs is through the design of particular regulations. A regulation is a process of enacting, monitoring, and enforcing particular rules.

Figure 84: Key to motivating people appears finding the right desires or needs and creating ways to satisfy them

Figure 85: Key to motivating people appears finding the right desires or needs and creating ways to satisfy them

According to Ryan & Deci these regulations can concern a manner in which people take in social values and extrinsic contingencies. Intrinsic desires concern the fulfillment of particular needs. Which needs are considered intrinsic to humans will be discussed in the next section, followed by a continuum of Regulatory Styles.

8.1 Related work, which needs to satisfy

Within cognitive psychology a large body of studies is concerned with the understanding of human motivation. Amongst others, studies brought forth Goal Theory (Ford, 1992) Achievement Motivation (Heckhausen, 1967) and Flow (Csikszentmihalyi, 2002). All of these present coherent and clear descriptions of possible reasons and mechanics that make people engaged. Most prominent in developmental psychology, however, and often cited in game studies appears Need Theory.

Need theory is a particular line of thought in cognitive psychology that suggests that people are and can be motivated if particular desires/needs are satisfied by the environment. One sub-set of Need Theory is Self-Determination Theory, which is researched in-depth by Richard Ryan and Edward Deci. This section discusses various versions of Need Theory, and explain why the needs brought forward by Self-Determination Theory (Ryan & Deci, 2000) may prove most applicable in autonomy-supportive game design with educational purposes.

This section discusses the applicability of four taxonomies on human needs/desires for autonomy-supportive game design (note, that this thesis makes no distinction between needs and desires, and uses them interchangeably).

1) Maslow's (1943) Pyramid of Basic Human Needs.

2) Riess's (2004) taxonomy of 16 human desires.

3) Malone's (1981) three intrinsically motivating features.

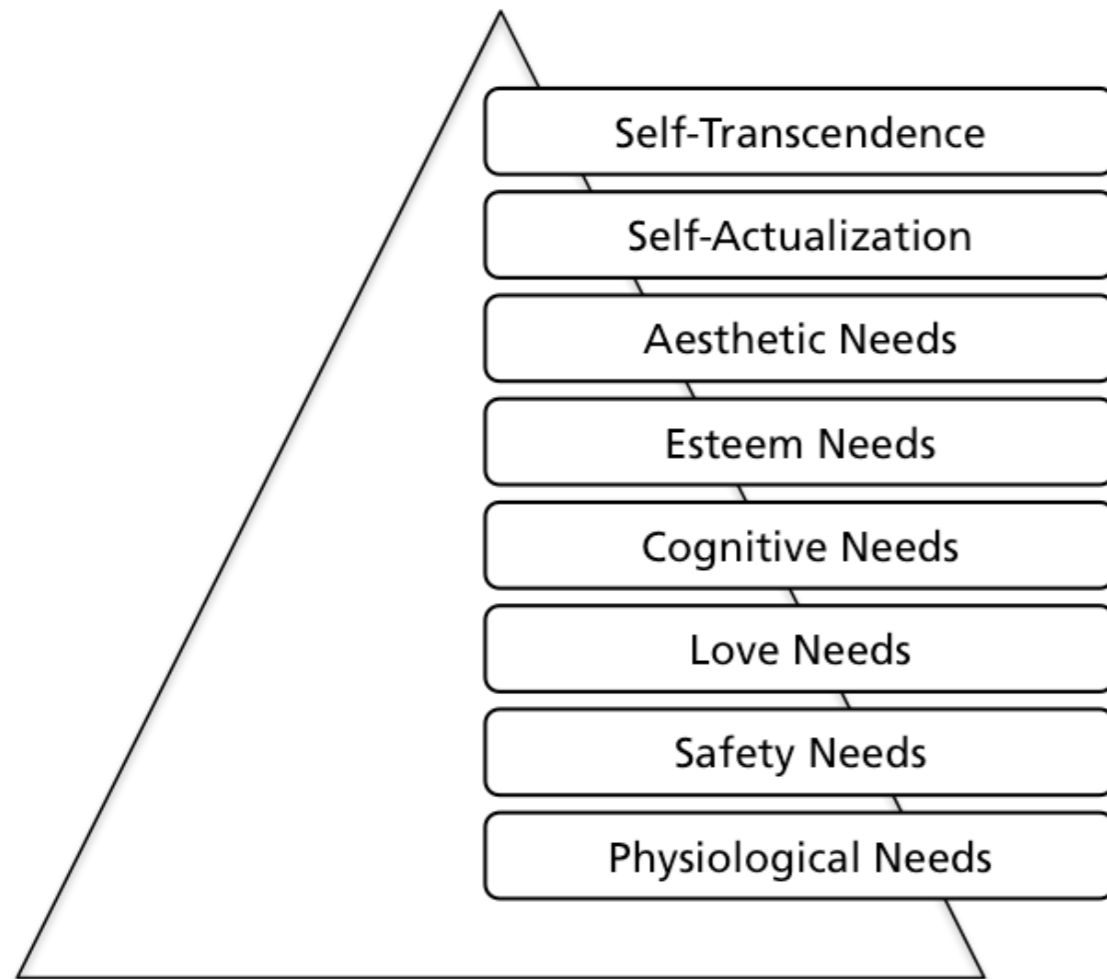4) Ryan & Deci's (2000) three universal human needs (Self Determination Theory).

The four theories are all discussed in light of autonomy-support. It will become clear that all three theories place high emphasis on autonomy as main motivator of human behavior. However, every scholar appears to approach this from a different perspective and in a different manner.

Pyramid of basic human needs

For example, Maslow's Pyramid of Basic Human Needs describes a hierarchical system of human needs, that all appear to work towards the becoming of an autonomous individual. Even the highest need of the pyramid suggest complete autonomy, since these individuals are so well motivated that they are able to present autonomy to others.

The Pyramid of Basic Human Needs consists of eight needs (see Figure 86). The needs on the bottom of the pyramid are physiological needs. These are considered the most pre-potent of all needs; suggesting that we should first care for our body before we are in need of something else. Or, in the words of Maslow (1943), a person who is lacking food, safety, love, and esteem would most probably hunger for food more strongly than for anything else.

Maslow's desires correspond to a certain hierarchy. When physiological needs are satisfied, the need for safety 'emerges'. When people have filled their stomach, they will probably search for a safe environment to rest and digest. The need for *Safety* is followed by *Love* needs (belongingness), *Cognitive* needs (to know/understand), *Esteem* needs (honor), *Aesthetic* needs (symmetry, order and beauty) and *Self-Actualization* (realizing one's potential). Maslow subsequently added the need for *Self-Transcendence* at a later time. With Self-Transcendence Maslow means: the willingness to connect to something beyond the ego, or to help others realizing their full potential.

For game designers, Maslow's pyramid may inspire particular design decisions. For example, the desire for self-transcendence can result in a co-operative multiplayer in which high-end gamers are connected to low-level players. This can be witnessed in *World of Warcraft* (Blizzard Entertainment, 2004). Frequently high-end gamers roam the low-level areas (e.g. Elwyn Forest). They sometimes help newer players out in their quests or present low-level players with valuable items (e.g. gifting). Another example of design for self-transcendence are wikis or forums in which people help one another out with all sorts of problems.

Another game in which the gameplay strongly relates to Maslow's pyramid is *MineCraft*. In *MineCraft* (survival mode) players need to save themselves from 'lurkers' by building a house before nightfall. Since the night crawling characters cannot enter a house, players are safe inside. Once safe, players can explore how to play the game and fulfill their cognitive, aesthetic and self-actualization needs. Like the pyramid, *MineCraft* slowly works towards presenting the players with increasingly more autonomy-supportive experience. Players are able to do more things and can personalize larger parts of the virtual world.

Critiques dispute the rigid hierarchy and the meager amount of empirical research of Maslow's pyramid (Huitt, 2001). Nonetheless, Maslows research paved the way for more studies into Need Theory. Additionally, its focus on autonomy-support (self-actualization and self-transcendence) suggests that autonomy is something that is gained over time and not immediately given. What's more, it appears to suggest that autonomy may be one of human's highest goals in life.

16 human desires

Maslow's pyramid describes which needs may follow one another in a hierarchical fashion. However, the pyramid does not give insights into the way these needs can be satisfied. Reiss' (2004, 2009) taxonomy may give a more in-depth insight into the reasons why people satisfy particular needs. In *The Normal Personality* (2009) Reiss differentiates between sixteen desires:

1. *Acceptance* (the need for approval)

2. *Curiosity* (the need to learn)

3. *Eating* (the need for food),

4. *Family* (the need to raise children),

5. *Honor* (the need to be loyal to the traditional values of one's clan/ethnic group),

6. *Idealism* (the need for social justice),

7. *Independence* (the need for individuality),

8. *Order* (the need for organized, stable, predictable environments),

9. *Physical activity* (the need for exercise),

10. *Power* (the need for influence of will),

11. *Romance* (the need for sex),

12. Saving (the need to collect),

13. Social Contact (the need for peer relationships),

14. Social status (the need for social importance),

15. Tranquility (the need to be safe), and

16. Vengeance (the need to strike back / to win).

Reiss' taxonomy consists of many different desires (or needs). Some of Reiss's desires appear difficult to apply in educational games. For example, desires for Eating, Family, Romance, and Vengeance may be less applicable in an educational setting. A teacher will probably not embrace the notion of allowing students to satisfy their desire to avenge other students. Nonetheless, Reiss' taxonomy may prove useful for designers by stipulating some desires to develop for. The needs could fuel the existing PLEX framework (Lucero & Arrasvuori, 2010) as initial concept for the experience design approach.

Additionally, Reiss's taxonomy reveals the complexity of motivation and suggests that motivation is very dependent on an individual's personality. As such, it suggests that every individual is unique and motivated by different reasons. Reiss compliments people's individuality with his elaborate taxonomy. The taxonomy attempts to align to the personality of individuals, suggesting that people are autonomous agents that are energized by a variety of reasons. It may therefore prove difficult to motivate people if scholars and designers only take the mere eight needs of Maslow into regard.

Challenge, curiosity & fantasy

Reiss's taxonomy appears rather overwhelming. Both Maslow's and Reiss's taxonomies may not always relate to educational and gaming contexts. Therefore, it may prove difficult to apply them in autonomy-supportive game design. It would therefore be insightful if the motivational needs were deduced from play-sessions instead. Cognitive psychologist Malone (1981) did just that. Malone deduced three intrinsically motivating features from various gameplay sessions.

Figure 87: PLEX cards: Fellowship, Completion and Erotism

Figure 88: PLEX cards: Sensation, Thrill and Subversion

Malone suggests that a game can satisfy desires for *challenge*, *curiosity* and *fantasy*. According to Malone these three desires are intrinsic to humans. He stated that we all have a desire to be challenged by our environment. Schools and games specifically tend to present individuals with challenges that are difficult to overcome. However, in an engaging game, challenges are never insurmountable. According to game designer Jenova Chen (2007), an engaging game creates a balance between the game's challenges (that may induce feelings of anxiety) with players' abilities (that, if too proficient, may induce feelings of boredom). If there is an optimal balance, Chen suggests that players can enter the 'Flow State' as depicted by Csikszentmihalyi (2002), where players become intrinsically motivated.

However, according to Malone, challenge alone is not enough. Games can also satisfy the intrinsically motivating need of curiosity. Curiosity - "The strong intrinsic desire we living beings have to know or learn something" (Tieben, Bekker, & Schouten, 2011, p. 362) - is studied elaborately in the field of human computer interactions. It suggests that people have a strong willingness to know what they do not yet know or understand. According to Berlyne (1960), curiosity is induced by novelty, complexity, uncertainty, and conflict. In game design, curiosity corresponds to Sid Meier's (2012) 'what if… question'. Meier explains how players come back to play *Civilization* (MicroProse, 1991) to see what kind of effects other / new decisions have on the game. The 'what if… question' keeps players engaged, maybe even intrinsically motivated to replay a game and 'clues' them to games (Rigby & Ryan, 2011).

Lastly, Malone discusses how fantasy, and especially children's fantasies of elves, pirates, space travel, and unicorns, can have an intrinsically motivating features that are well embedded in video game culture. MobyGames lists 5.357 games (out of 47.841) in the Fantasy genre. With roughly 10% of fantasy games availabe, it is safe to assume that fantasy is a well-established genre in games. Sci-Fi or futuristic themes are even more prominent, with 7.312 games listed at MobyGames. Especially older games (from the 80s) appear themed to Fantasy or Sci-Fi genres.

Today's industry brings forth a more diverse thematic experience, making games that deal with real-life issues like losing loved ones (*Fragments of Him* (SassyBot Studio, 2014)), or small lies to hide one's sexuality (*A Beautiful Sunday* (Aben, Arnett, Boles, & McDonalds, 2014)). Still, Malone suggests that games can satisfy the desires of curiosity, challenge, and fantasy. If they satisfy these desires, the game appears rather engaging.

Habgood et al. (2005) studied Malone's claim that fantasy is an intrinsically motivating feature. Habgood compared two games with one another. The games were almost identical, but they differed on the fantasy theme. The fantasy-rich game did not result in higher motivation in comparison to the game with little (or no) fantasy theme. Habgood's findings ask for a reevaluation of Malone's intrinsically motivating features.

Malone's suggestion that challenge and curiosity are two intrinsically motivating features, suggests that game designers could search for something that relates to people's interests (Reiss's taxonomy comes to mind). As a result, the satisfaction of a desire appears to 'unlock' a desire of a higher order (Maslow's pyramid comes to mind). Above all, Malone's intrinsically motivating game features focus upon the player as an autonomous agent that needs to be challenged and inspired by the game. The next theory on human motivation appears to bring forth the most applicable way to accomplish this.

Self Determination Theory
Within Need Theory, one line of thought is called Self-Determination Theory. Its most prominent evangelists are Richard M. Ryan and Edward L. Deci. Like Maslow, Reiss, and Malone, Ryan & Deci (2000) suggest that an environment can satisfy particular needs. If the needs are satisfied, an individual can become motivated to act. Ryan & Deci formulate three universal human needs. These three needs are: *Competence, Autonomy,* and *Relatedness* (Deci et al., 1994).

Competence concerns the individual's sense of self-efficacy. Self-efficacy describes an individual's belief in being able to overcome obstacles and challenges successfully (Bandura, 1997). It suggests a sense of agency, which Murray (1998) describes as a feeling of mastery and control. Murray suggests that this feeling of agency is strongly related to interactive media, such as games.

Autonomy concerns the self-legislation and self-determination of one's actions and progression. It describes an opportunity for individuals to generate their own path.
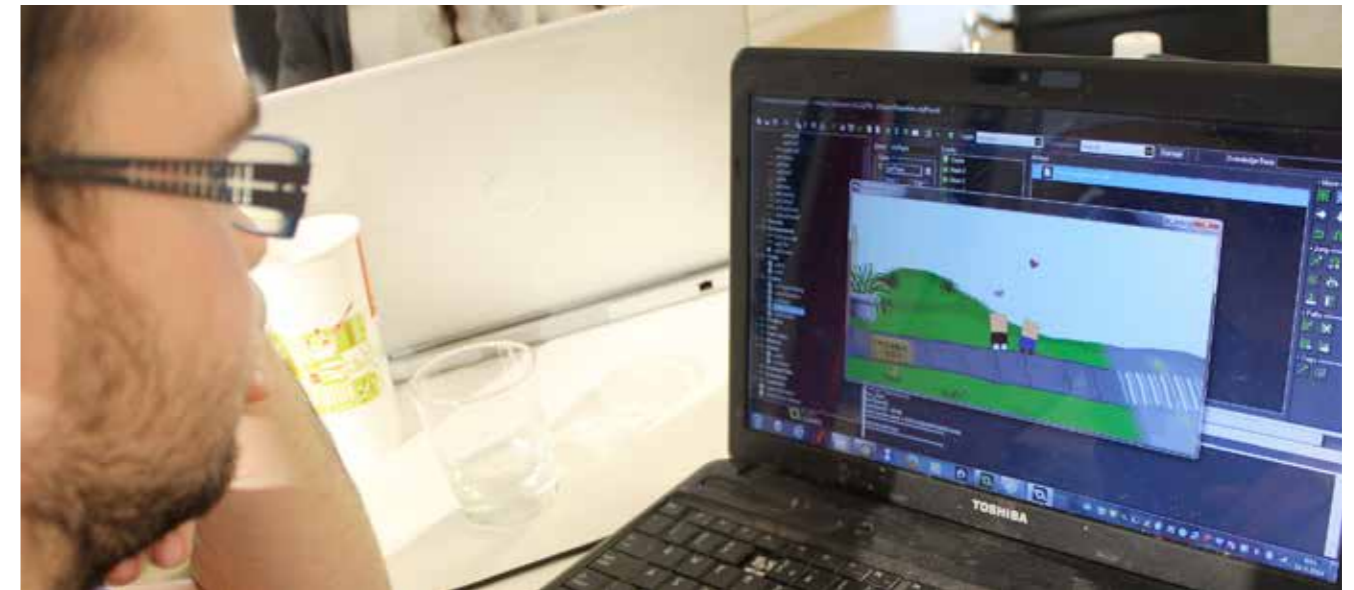
Games can facilitate these autonomous experiences. As a result one's locus of causality becomes internal. This means that individuals believe that they can influence a situation, or that they are responsible for how events unfold (DeCharms, 1968). Autonomous people feel that they are responsible for their own progress.

Relatedness concerns the relation with other individuals in regard to the activity at hand. This feeling of belongingness is best satisfied by people with whom individuals have a meaningful connection. Ryan & Deci (2000) call these people 'significant others'. Needs for relatedness can therefore be satisfied by significant others.

Self-Determination Theory states that if needs for competence, autonomy and relatedness are satisfied, students can intergrate learning regulations to the self. Integration refers to internalization in which the person identifies with the value of an activity and accepts full responsibility for doing it (Deci et al., 1994, p. 121). By internalizing a regulation the locus of causaility (DeCharms, 1968) is experienced as being internal to the indiviual. This makes people feel empowered and in charge of their progress and development.

8.2   Self-Determination Theory

The reason to choose Self-Determination as a theoretical framework is multifold. For one, Self-Determination is already well established as a theory to understand motivational aspects in both domains (education & gaming). In education, the satisfaction of needs for competence, autonomy, and relatedness, has shown increases in motivation (Rigby et al., 1992). What's more, scholars have studied the theory in the domain of games, either to discuss the motivational value of violence in games (Przybylski, Ryan, & Rigby, 2009), or to emphasize the value user research and intuitive controls (Ryan et al., 2006).

Another aspect of Self-Determination theory is that it excludes the aforementioned desires that this thesis regards as unbefitting an educational context. Desires of social status, honor and vengeance may frustrate the integration of external contingencies to the self. Instead, Ryan & Deci (2000) appear to propose different ways to satisfy needs for competence, autonomy and relatedness. Lastly, Self-Determination theory brings forth a way to qualify motivation in more than being either high or low, presenting designers with a better insight of the possible impact of their game upon players' motivation and clear tools to design with. Ryan & Deci call these different expressions of motivation Regulatory Styles.

8.3 Regulatory Styles

Ryan & Deci (2000) describe six regulatory types in the Self-Determination Continuum (see Figure 91). The process by which people are enacted, monitored, and enforced to comply with particular rules can qualify students' motivation in terms of their external influences and personal willingness to act.

According to Ryan & Deci (2000), there are five Regulatory Styles that are associated with three types of motivation: *amotivation, extrinsic motivation* and *intrinsic motivation*. In Figure 91 the Regulatory Styles are set apart and are categorized by their connected type of motivation, perceived locus of causality and relevant regulatory processes.

The next sections will elaborate upon the five Regulatory Styles described by Ryan & Deci. First the left side of continuum will be described (external and introjected regulations), followed by the right site (integrated and intrinsic regulations). It will become clear that the golden mean (identified regulation) is found in-between these Regulatory Styles: presenting designers with an applicable tool to satisfy needs for competence, autonomy and relatedness in an autonomy-supportive environment.

The next sections describe all five Regulatory Styles as depicted by Ryan & Deci in light of game and educational design. Every section starts with a short description of the style followed by examples of their implementation in game design and suggested pros and cons for educational purposes. Every section concludes with a design suggestion of the respective Regulatory Style in serious game design. In order of appearances, the sections discuss:

1. External regulations, as a restrictive though powerful design tool for explaining and instructing the basics of an autonomy-supportive game.

2. Introjected regulations, as an initial strong motivator, but only if well considered and applied with care.

3. Intrinsic regulation, as the 'holy grail' of motivation, but the most difficult to accomplish.

4. Integrated regulation, as a 'second best' to intrinsic regulation and still difficult to accomplish and hard to measure.

5. Identified regulation, as the most feasible design direction when it comes to serious games with educational propositions.

This section excludes non-regulation. There is little to state about this regulatory type, since it is in no way a productive regulation to engage in learning activities. Additionally the structure of this section differs from the structure of the continuum, because identified regulations are most clearly described if the other types are well understood.

External Regulations

Learning for external reasons is performed to satisfy an external demand or reward contingency. In gaming, external regulations can be found in scores, badges, trophies, achievement systems, and reinforcements such as dying, loosing gear, and finding treasures.

For example, the game *Dark Souls* (From Software, 2011) is infamous for its unforgiving external regulations. Death in *Dark Souls* results in the loss of all carried souls and humanity, both of which act as forms of currency in the world. Players have one chance to recollect the souls and humanity by reaching the location of their death; failing this, the items are permanently lost.

Although gamers may be accustomed to these kinds of punishments, students can experience this differently. External regulations can be experienced as controlling and/or alienating. Students who feel externally regulated show less interest, value, and effort towards achievement (Ryan & Connell, 1989). Externally regulated students tend to disown responsibility for negative outcomes, blaming others such as the teacher (Ryan & Deci, 2000).

Nonetheless, external regulations appear to enforce compliant behavior when needed. Traffic and prohibitory signs are excellent examples of external regulations that appear to meet their demands. They clearly state their purpose without explaining why or how. This does not mean that all people abide with traffic laws though. External regulations are very strong instructional tools, but do not necessarily result in compliant behavior.

In summary, external regulations control and steer behavior. This can be useful in the short run, especially for instructive practices and informative use. However, external regulations may not strengthen motivation over time, and at worst they may alienate students from the learning process.

Introjected Regulations

Introjected regulations correspond with external regulations in the way that the main stimuli are external to the person. However, introjected regulations differ from external regulations because they target personal values and norms.

Introjection involves taking in a regulation but not fully accepting it as one's own (Ryan & Deci, 2000, p. 72). Introjectedly regulated individuals tend to attain ego enhancements such as pride or honor. These people demonstrate their abilities in order to maintain feelings of worth. As a result, behaviors are performed to avoid guild or anxiety.

For example, *FourSquare* (Crowley & Selvaduri, 2009) rewards repetitive GPS-coordinate log-ins with hierarchical titles. Players can become the 'Mayor' of a location after achieving more logins than other users in that location. The term Mayor has a strong socio-cultural value of importance and honor. If players do not login enough, they will lose their status to another player. *FourSquare* players maintain their login behavior in order to avoid losing their socio-culturally defined status. The main game mechanics of *FourSquare* can therefore be considered introjectedly regulating.

Likewise, the 'honor' system in *World of Warcraft* (PvP instances) measures the players' sense of worth by the number of kills and battles won. Titles in the honor system range from Private to Grand Marshal, again connecting to socio-cultural (militaristic) values of importance and honor. Other introjected regulations are found in high-score lists, socio-cultural naming of characters, game narratives etc.

In education, Ryan & Connell (1989) state that introjected regulation is positively related to expending more effort. However, introjected regulation is also related to feeling more anxiety and coping more poorly with failures. If people feel 'dumb' for making mistakes, they will logically create a strategy in which failure is not an option. It appears that introjected regulation has a strong negative aspect to it.

Despite the negative aspects of introjected regulations, some serious game designers incorporate the socio-cultural values of 'worth' in their games. Examples are *Math Attack*'s (First World Studio, 2007) use of IQ for scoring points. In correspondence players' of *Dr. Kawashima's Brain Training* (Nintendo SDD, 2005) are rewarded with something called 'brain age', connecting to the socio-cultural valuing of age.

Figure 92: FourSquare uses introjected and external regulations to motivate players
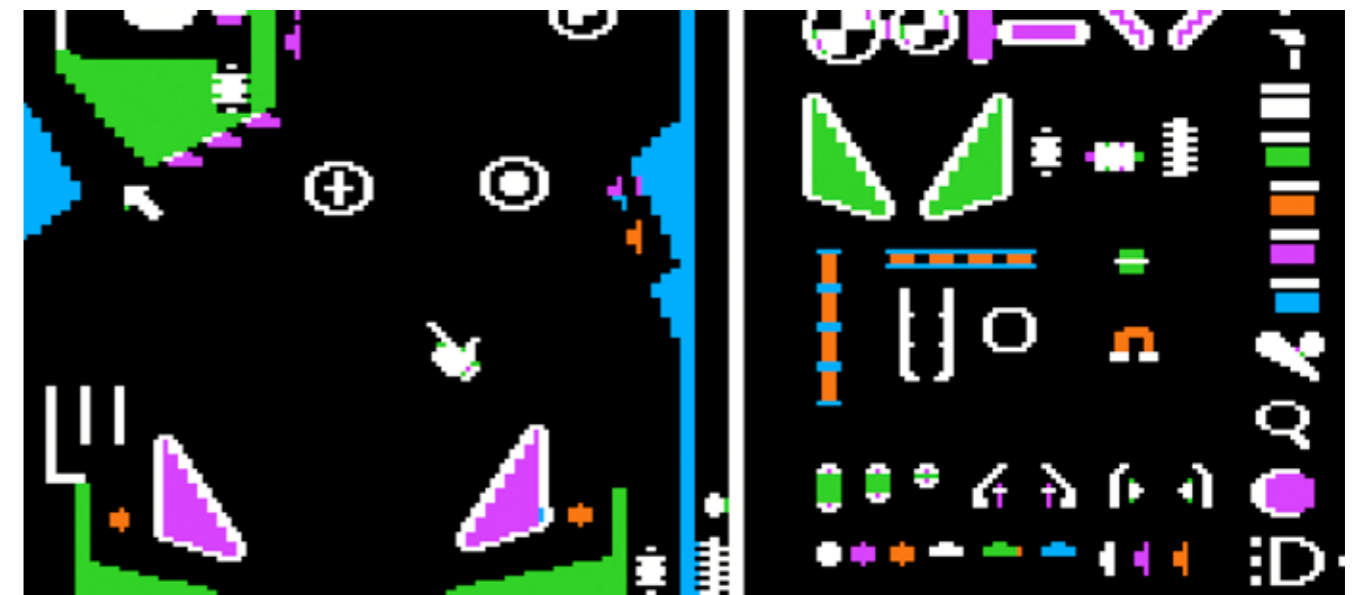
Figure 93: Pinball Construction Kit is part of a series of level editors, focusing on players' intrinsic desire to construct something new and personal

Both scoring systems (IQ's and Brain Ages) connect to socio-cultural thoughts on self-worth and social status. They can therefore be considered introjected regulations.

The negative aspects (learning anxiety and coping poorly with failures) of introjected regulation may overshadow its positive aspects (expending more effort). Designers are therefore warned to implement introjected regulations cautiously. This thesis even proposes to avoid the implementation of introjected regulations in autonomy-supportive games for learning.

Intrinsic Regulations

External and introjected regulations suggest that students' culture and environment largely determine their motivation. The regulations can therefore be called extrinsic - coming (partly) from outside the individual. Intrinsic motivation (and regulation) suggests that motivation comes from within the individual.

Intrinsic suggests that individuals do not need any reinforcement (i.e. regulation) to engage in an activity because the activity is satisfactory in itself. People appear to care less for the sub- or end-goals. Instead, they are focused upon the activity itself. Intrinsically motivated people can experience a sense of flow (Csikszentmihalyi, 2002). They forget time and place. This 'regulation' is experienced when individuals internalized the (learning/gaming) regulations to the 'self'. This means that they have brought the rules, goals and style of the activity into congruence with their personal dispositions.

Intrinsic motivation is best witnessed in games that offer a particular freedom and few clear goals. Amongst others these incorporate construction games like *Pinball Construction Kit* (BudgeCo, 1985) and *MineCraft* (Persson, 2009), free-roaming games like *Grand Theft Auto III* (DMA Design, 2001) and *Just Cause 2* (Avalanche Studios, 2010). Also in puzzle games like *ScribbleNauts* (5th Cell, 2009) or 'God' games like *The Sims* (Maxis, 2000), players can play in many different ways. All these games give players the opportunity to explore, experiment, and struggle with the game's mechanics. The games above can be considered autonomy-supportive, which is not surprising, since intrinsic regulations are strongly associated to autonomy.

Intrinsic motivation is the most self-determined behavior and willingness to act that Ryan & Deci describe in their elaboration on the Self-Determination Continuum. The play emerging from the above games share qualities with intrinsically regulated behavior that is less found in other games. For one, the freedom presented in the games offers players the opportunity to generate their own path through the game. Secondly the games often support various playing styles, increasing autonomous experiences in the game. Lastly the games have players experiment, explore and struggle with the game's mechanics in a corresponding way, as autonomy-supportive learning environments tend to offer.

In education, intrinsically motivated learners expend more effort and show increased mastery (Ryan & Deci, 2000). They tend to conform easily to new learning approaches and will probably explore various learning styles to get an understanding of the subject matter. It is exceptionally difficult to 'intrinsically motivate' individuals, since the motivation must come from the individuals themselves. It is contradictory to state that (external) others can motivate someone from the inside. Still, Deci, Eghrari, Patrick & Leone (1994) claim that the internalization of external regulations can occur if needs for *competence*, *autonomy* and *relatedness* are satisfied (more about this in section 8.3).

Integrated Regulations

Integrated regulations describe regulations that are partly internalized to the self. The individual engages in the activity because the activity is considered satisfactory in itself; however the individual remains focused on attaining a particular goal.

The practice of grinding is an example of integrated regulated behavior. Amongst others, grinding is witnessed games like *World of Warcraft* (Blizzard Entertainment, 2004), *Secret of Mana* (Square, 1994), and *Pokémon Red / Blue* (Game Freak, 1996). It describes the practice of repetitive 'killings/wins' to acquire in-game currency, items or experience points. *World of Warcraft* players can spend hours killing the same enemy in order to loot a specific item or to complete a quest.

In education, integrated regulations are found in a particular student that is referred to as an (over) achiever. These students enjoy learning, but they still work to ascertain a high mark. As such the learning is not solely done from intrinsic motivations. This differs from external regulations where the learning is solely done to ascertain external condition (i.e. rewards, punishments).

The differences between integrated and intrinsic regulations are difficult to recognize in players and students. Both are associated with highly motivated behavior without the negative aspects connected to the aforementioned extrinsic regulations. In addition, integrated and intrinsic regulations are highly personal and may differ significantly between individuals, which make it very difficult to facilitate this kind of motivation.

Identified Regulations

Identified regulations take 'the best of both worlds', as they can be positioned in between external regulations and intrinsic regulations. Identified regulations concern the conscious valuing of rules, procedures, and goals. Individuals perform an activity because they understand how it helps them to achieve a personally valued goal. What's more, people feel that the activity matters to them and that it fits their personality. In other words, they can identify with the regulation.

In comparison to integrated regulations, the regulations are identified as being of relevance but not (yet) integrated to the self. This identification can occur in two directions. In books and movies, identification occurs mainly in one direction. People can identify with a character by recognizing (as in understanding) the character's personality and actions. In games, players can understand the personality of a character, but players themselves perform the actions. Identification in gameplay can be found in recognizing personal attributes in the game, and in being able to express one's identity at the same time. Players not only identify with the game's aesthetics and mechanics, but with the gameplay (the dynamics) as well. Players identify themselves with the way they play a game (Deen et al., 2011). By playing the game, players change the existing configuration of a game. Players 'leave something of themselves behind' in the game.

Identified regulations create a frame of reference to work with and offer opportunities to 'put something of oneself' into the regulation. Game scholars refer to a similar frame when describing the Magic circle (Copier, 2007; Klabbers, 2006; Salen & Zimmerman, 2003). The Magic Circle, coined by Huizinga (1951) describes a place outside 'real life' where new and different rules create boundaries. Within these boundaries play is made possible. The Magic Circle is considered magical because the boundaries of play can emerge seemingly 'out of nowhere', creating a space that is real and imagined at the same time. In a way, the Magic Circle can be regarded an environment in which autonomy-support is possible; it all depends on the strictness of the circle's constraints (e.g. boundaries).

Copier (2007) recognizes the Magic Circle in role-play communities in *World of Warcraft*. Some communities adhere to rather strict regulations. For example, the use of abbreviations and talking 'out of character' is prohibited in the main chat-channel of role-play servers on *World of Warcraft*. Players are supposed to 'keep-up appearances' and have a backstory for their character ready. All rules and regulations of role-play are in place to ascertain a fun experience for all players. The rules are adhered to, but remain in a continuous flux, which is subject to social negotiations between players, designers and the game system. From these negotiations, new rules and playful opportunities emerge. Role-play can be considered a form of identified regulations, since players adhere to rules (which are clearly socio-culturally created) in order to obtain a goal that is valuable to both the players and the system.

In education, identified regulations can be found in the New Learning movement (Simons et al., 2000) and project-based education. The New Learning movement places high emphasis on students' awareness of their progress, and more importantly of how they learn. By understanding their own strengths and abilities, students can determine for themselves what skill to develop or which subject to pursue. As a result students can identify more easily with the learning content and the way they learn. In project-based education, as proposed by van Ernst (2002), students buy a wrecked car. Together with other students, they repair the car in order to sell it for a profit. The car repair incorporates many educational aspects from various disciplines (economics, mechanics, mathematics etc.). By relating the school courses to the 'meta-project' of repairing and selling a wreck, students work towards a goal that makes the courses relevant to them. In this way students can put something of themselves into the learning, generate their own path, and recognize themselves in both the process of repairing the car and in the final car itself.

It appears that education already understand the value and applicability of identified regulations within their practice. Serious game designers could do the same: Creating a game that facilitates the conscious valuing of rules, procedures and goals by the player, and having players engage with the game because they understand how it may help them to achieve a personally valued goal. Autonomy-supportive games can create these environments. The fixed mechanics set the stage by depicting the boundaries of the game, whilst the restructureable elements of the game can offer players the opportunity to value these mechanics by exploring, experimenting and struggling with them.

One way of connecting to the values of players, and to have them positively evaluate the fixed mechanics is through the process of Regulatory Fit. The concept of Regulatory Fit, as described by Bianco et al. (2003) suggests that motivation towards education can be improved when the tone of instruction corresponds to the implicit theory students have about the learning. For example, if students express boredom in history class, teachers may feel obliged to enliven the tone instruction by making history 'fun'. A teacher can try to add some jokes, interesting anecdotes, etc. However, students' implicit theory of history is not connected to 'fun', but to 'importance'. According to the scholars, the teacher could change their tone of instruction to something of 'importance'. According to Bianco et al. motivation to learn about history may increase if the tone of instruction fits the implicit theory students have about history lesson.

Designers and teachers could study the implicit theory that students have about the learning and connect their design to fit students' expectations. As a result, it may be easier for them to value the fixed mechanics in a positive way, since they correspond with what they already think and feel about the subject.

In summary
The above sections discuss the five Regulatory Styles of the Self-Determination Continuum as depicted by Ryan & Deci (2000). This section summaries the pros and cons of these regulatory types in relation to autonomy-supportive serious game design.

External regulations appear very useful tools for short and fast bursts of information. They can create focus and structure, as they rapidly define the boundaries (rules) of a learning environment. However, excessive use of external regulation can lead to disownment of responsibility for learning. External regulations appear useful in the short run but may have less (and even undesired) impact in the long run.

Introjected regulations (playing with feelings of honor and self-esteem) are easily designed by building competitive systems by adding high-scoring lists and conflict situations. Introjected regulations may appear promising at first glance, as students expend more effort. However, due to their impact on students' sense of 'worth' they can lead to performance anxiety. Instead of learning from making mistakes, students may tend to avoid failure to maintain their sense of pride and honor. Designers are therefore warned to be considerate when implementing scoring and achievement systems.

Integrated regulations are regulations that are partly internalized to the self. The individual engages in the activity because the activity is considered satisfactory in itself; however the individual remains focused on attaining a particular goal.

Intrinsic regulations are clearly the end-goal for applied game designers. These players do not need any reinforcements, as the activity is satisfactory in itself. According to Deci et al. (1994) internalizations can take place when someone feels competent, autonomous and related to others. Intrinsic regulations are difficult to design in educational environments since the freedom of learning is often subject to standardized testing and time constraints (see section 0). However, designers can come close to intrinsic and integrated regulations through the design of identified regulations.

Identified regulations describe an environment that is rather goal oriented, consisting of clearly defined rules which offer players a particular freedom to put something of themselves in the game. In other words, identified regulations appear to correspond to autonomy-supportive environments.

The next sections explain how design decisions based on identified regulations can satisfy needs for *competence*, *autonomy* and *relatedness* in games.

8.4 Satisfying universal needs through identified regulations

According to self-determination theory, motivation towards learning can increase if needs for *Competence* (I can do it), *Autonomy* (I do it in my own way), and *Relatedness* (I do it with significant others) are satisfied (Deci et al., 1994). By satisfying these needs students may internalize the learning regulations and become intrinsically motivated to learn (Deci et al., 1994). This section describes how games can satisfy needs for competence and relatedness through identified regulations. It will become clear that the use of external regulations is sometimes warranted, since it can save precious time.
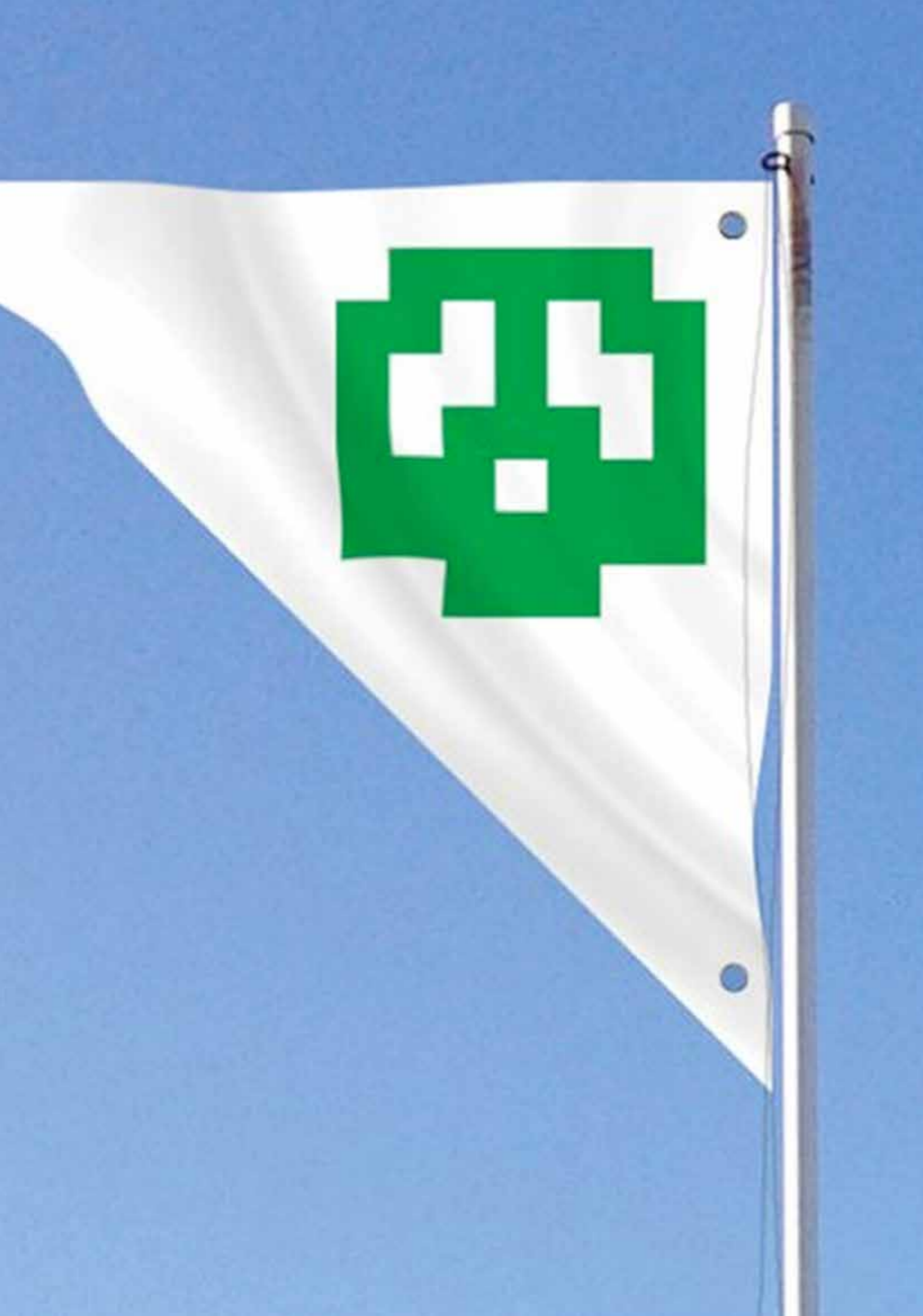
Satisfying needs for competence

There are many ways to satisfy needs for competence. Feelings of competence address the perceived ability of (possible) successful engagement, or "The beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations." (Bandura, 1997, p. 4.) In short: *"I can do this!"*

This section discusses how needs for competence can be satisfied through identified regulations.

1. From Scaffolding [i + 1] to Zone of Proximal Development

2. From Feedback to Progressive Feedback

[i + 1]
The increase in a game's difficulty setting can be characterized as a learning curve, in which knowledge builds forth on former knowledge. Wood, Bruner and Ross (1976 in Verenikina, 2003) dubbed this method *scaffolding*. Within a scaffolded curriculum the difficulty of the learning content is raised step-by-step, by breaking the content into manageable pieces that are only a little above students' cognitive level (Verenikina, 2003).

The scaffolding principle can be described with [i + 1], in which i stands for the current knowledge zone, and 1 represents the manageable piece of knowledge that is only a little above students' cognitive level. By scaffolding the learning process, students' ability to overcome particular challenges might grow. As a result, students progress to the next step in the learning ladder. Learning can therefore be seen as a process of progression.

Progression in games often follows a scaffolded growth as well. Section 3.4 showed how game designer Shigeru Miyamoto scaffolded the first level of *Super Mario Bros.* (Nintendo EAD, 1985). The example illustrates how scaffolding can be subtly integrated into gameplay, without modeling the teaching style of instructor and explainer (see section 2.2). As such, if we look at the gameplay models, *Super Mario Bros.* would be classified as having the teaching style of a facilitator. Still, the game's level design is rather externally regulated.

Only when level 1-1 is finished, players can progress to the next level. Since the game does not include a 'save' function, players are forced to complete each level to receive access to the next. Players are able to partly determine which levels they play themselves only after discovering the warp-zones later in the game.

In its most shallow implementation, scaffolding can be considered an external regulation, since the game space enforces the order in which skills are mastered. As such, scaffolding controls and steers learning behavior. This can be useful in the short term, especially for instructive practices, but may not facilitate an autonomy-supportive environment. The Zone of Proximal Development is similar to scaffolding but does offer an autonomy-supportive way of learning.

Figure 95: The Flagpole of Super Smash Bros. [i + 3]

Zone of Proximal Development

The Zone of Proximal Development concerns an environment with many scaffolded paths to choose from (see section 2.3). Students can determine which (learning) goal to achieve or pursue. Therefore, the Zone of Proximal Development corresponds to identified regulations. Because players can explore, experiment, and struggle with various routes, players evaluate how a particular path may help them to accomplish a particular goal. Therefore the focus is less on the successful completion of a level, and more on understanding the relevance of particular exercises to reach a goal.

Feedback

Games offer great opportunities to train specific skills. For example, players of MMORPGS may enhance their leadership capabilities by performing as guild leaders (DeMarco, Lesser, & O'Driscoll, 2007; Reeves & Malone, 2007). Green et al. (2010) suggested that action games can increase players overall attention skills, and Franceschini et al. (2013) suggest that playing *Rayman Raving Rabbids* (Ubisoft Montpellier, 2006) drastically improves the reading abilities of children with dyslexia.

Others suggest that games can teach literacy (Gee, 2003), improve cognitive development (Brock et al., 2008), stimulate happiness and creativity (M.D & Vaughan, 2009), enhance social-emotional growth (Singer et al., 2006), foster early cognitive development (Sheridan, Howard, & Alderson, 2010), educate naturally (Elkind, 2007), or even change the world (McGonigal, 2011).

However, it proves difficult to transfer abilities that have been acquired in games to other activities or domains (Clark, 2001). As a result, practicing in games may not be of use to activities outside the game. The reason for the lack of knowledge transfer may be caused by players' ignorance of learning during play. Serious game developer Michael Bas (Ranj Serious Games) called this accidental learning; players will 'accidently' pick up new skills but may not be aware of their competence. Johnson (2005) dubbed this learning process a *Sleeping Curve*. The learning curve 'sleeps', because gamers are not aware of learning during play.

One way to make students aware of their progress is by presenting them with feedback. For example, marks and profile matrixes are ways to increase students' awareness on progression. Marks provide useful information about competence and mastery (M. R Lepper et al., 2005). Still, some students fail to understand how marks communicate progression, and other students simply do not care for them.
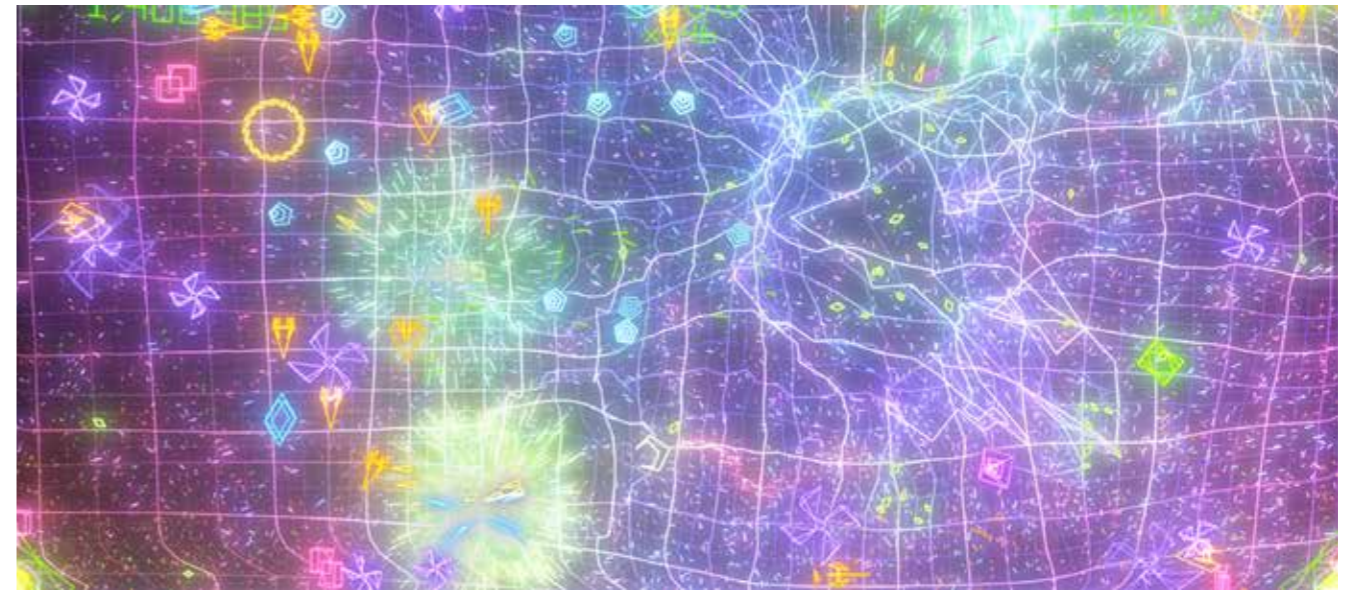
At the Fontys Information Communication & Technology the use of marks is subject to a continuous debate. This gave rise to Profile Matrixes (Bordewijk, 2009). Profile matrixes communicate students' ability more specifically than an abstract mark does. Amongst others the matrixes describe the meta-skills professional demeanor, problem solving skills and conceptual thinking.

Feedback systems in games are strikingly similar. Instead of 'marks', games utilize the external regulation of 'points'. And instead of Profile Matrixes games qualify an accomplishment with 'achievements'. Games "Have become more sophisticated in how they provide performance feedback and acknowledge the prowess of players." (Przybylski et al., 2010, p. 156.) However the scoring and achievement system appears capricious at best and unsporting at worst. This becomes clear in debates about positive and negative reinforcements in game design (Hecker, 2010; Salen & Zimmerman, 2003).

Hecker discussed the achievements system of Xbox-Live, stating that achievement-systems should be designed with careful consideration. For example, the Xbox-Live achievements congratulate players with points and small texts. In *Geometry Wars 2: Retro Evolved* (Bizarre Creations, 2003) players are rewarded with the *Millionaire* achievement if they score at least 1.000.000 points in all single player modes. This is quite an accomplishment.

More colorful achievements, such as the *Wax On* and *Wax Off* achievement invite players to perform complex fly scenarios. Although the way to receive the *Millionaire* or *Wax On* achievement differs significantly, both activities are rewarded with the same pop-up. Players may expect a greater reward for the *Millionaire* achievement than for the *Wax On* achievement.

The achievement system appears capricious in granting rewards in regard to the workload needed to receive the achievement. The arbitrary nature of Xbox-live achievements may be problematic for how players develop a sense of self-esteem from feedback. One moment players are the considered larger than life by the system after watching the first cinematic of *Mass Effect 2* (BioWare, 2010), only to discover that the next achievement asks players to invest a serious amount of time and energy in the game.
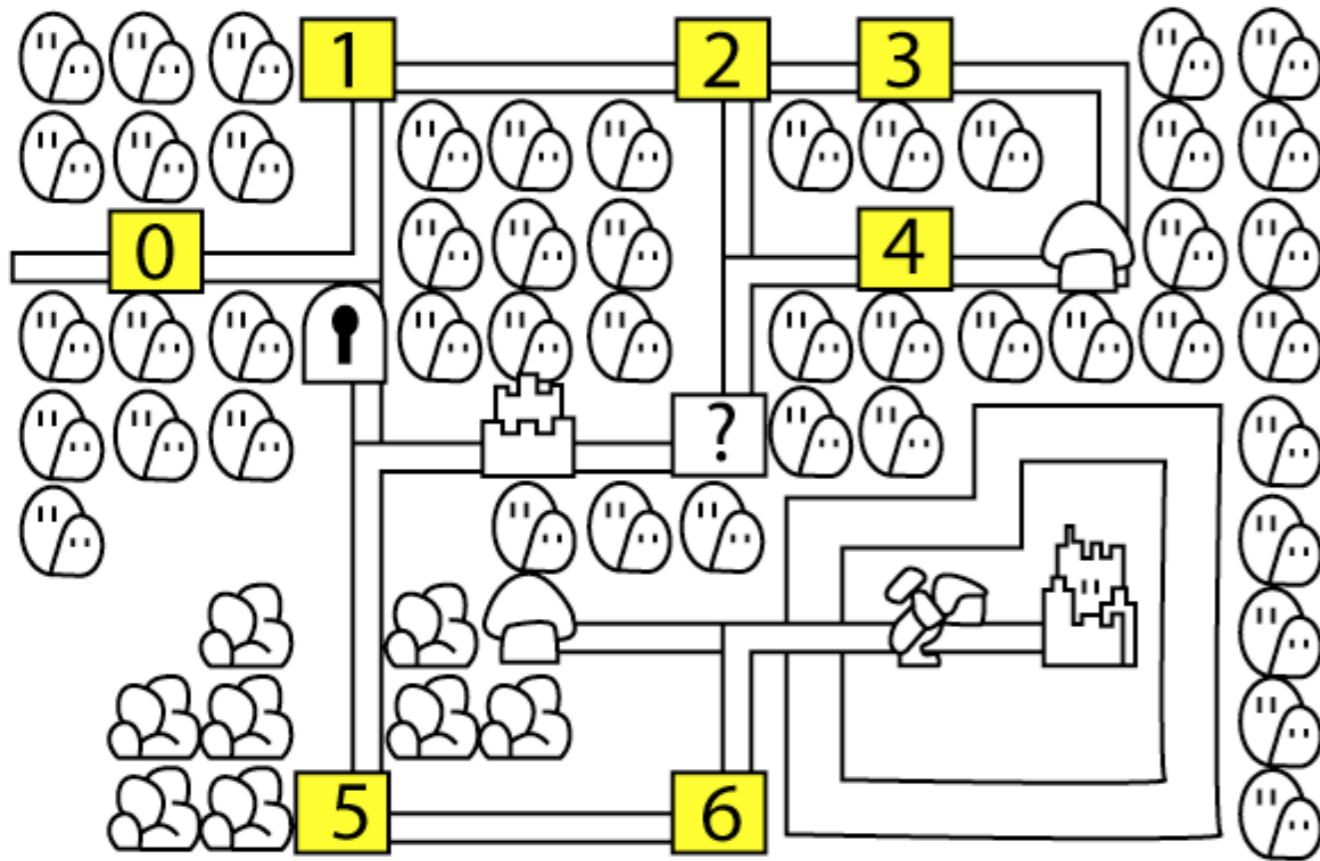
These formalizations of players' competency tend to celebrate only particular qualities. For example the list of Xbox live Achievements for *Forza Motorsport 5* (Turn 10 Studios, 2013) consists for the larger part of rewards for short completion times. Whether or not players enjoyed playing the multiplayer with friends or are making impressive jumps with their car is not quantified by the system. The same is true for the fighting game *Soul Calibur II* (Project Soul, 2002). The larger part of the achievement consists of defeating other fighters. Creative takes on the game, like playing with the characteristic movements of the fighter Voldo in *Dance Volvo Dance* (*Dance, Voldo, Dance*, 2010), are not captured by the system. Scoring and achievement systems tend to enforce one particular style of playing and fail to recognize creative and more playful styles.

Although games are great instruments to provide "useful information about competence and mastery" (M. R Lepper et al., 2005, p. 191), the excessive use of scoring and achievement systems may result in the design of an environment in which players feel externally and/or introjected regulated.

The design of this form of direct feedback may reduce the autonomy-support of the game. As a result, players may feel less invited to explore, experiment and struggle with the game system to generate their own path to a solution. However, feedback can be presented in various forms and styles. One particular style of feedback that does connect to identified and integrated regulations is Progressive Feedback (Deen & Schouten, 2011).

Progressive Feedback

Progressive Feedback is explanatory and instructive in the sense that it expresses what is completed and what is to come. The feedback communicates progress and it outlines prospective progression. This means that Progressive Feedback has a reflecting and activating role. It describes both 'the learned' and the 'to be learned'. This way the reward of successfully accomplishing a learning goal is not finite, but opens the gate to new learning experiences.

Progressive Feedback can be designed by using the Advent Calendar Method (Deen & Schouten, 2011). The Advent Calendar Method may be most discernable by its implementation in *Super Mario Bros. 3* (Nintendo R&D4, 1988). Every game level is visible on the world-map. After succeeding at one level the next level becomes available to the player. Like an advent calendar, players can perceive the coming events and which events are finished (see Figure 98). This way, the game explains what is accomplished, and what should be accomplished next.

In order to create an environment that is autonomy-supportive and satisfies needs for competence, the design, Zone of Proximal Development, and Progressive Feedback can help in realizing this goal. It should be taken into account, however, that introjected regulatory experiences can only be applied after careful consideration, and that it may be prudent to utilize external regulations only to set the stage and explain basic boundaries or introduce new knowledge actors and gameplay elements.

Satisfying needs for relatedness

This section illustrates how needs for relatedness can be satisfied through identified regulations. Relatedness suggests a relation with another individual. According to Ryan & Deci (2000), this individual can be human, inhuman or even imaginary. As social negotiations differ between people, the satisfaction of needs for relatedness differs per person and per context. In conjunction to the former section, this section will discuss three design elements and their associated Regulatory Styles, namely:

1. Parallel play as integrated regulation.

2. Social interdependency as identified regulation.

3. Gameplay sharing as identified and integrated regulation.

This section will point out how to avoid external and introjected regulations when satisfying needs for relatedness, and how to focus upon identified and integrated regulations instead.

Parallel play

People do not have to engage in social negotiations (i.e. active communications) with others to feel connected or related to people in their surroundings. One way to satisfy needs for relatedness is *Parallel Play*. Parallel play is performed together, but not necessary with one another. Parallel play describes a social playful activity that occurs alongside one another. Children, for example, can play near each other without trying to influence one another's behavior.

The children in Figure 99 (right) do not play together. Instead, they play alongside each other. Still, children report that did they did play together (Verhulst, 2003). The children from this example appear related to one another by playing with the same toy although there appears that there is otherwise no other social interaction.

It may appear that parallel play is doing a bad job in satisfying needs for relatedness. It will become clear that parallel play is actually a rather strong (and cheap) instrument to make people feel connected. The availability of others engaging in the same or a similar activity may prove enough to satisfy needs for relatedness, even if the impact can be considered minimal.

The satisfaction of need for relatedness can be witnessed in Massively Multiplayer Online Role Playing Games. In these MMORPGs, people play together by means of the internet. Research into MMORPGs suggests that motivation to play can dwindle when real 'others' are absent. Kalstrup (2003) describes how The Tunnel of Ro, an underground dwelling in *EverQuest*, was initially the busiest place in Antonica (a continent in the game world). Players visited the tunnel to trade game items. A lot of socializing and communication was generated around this meeting place. However, with the implementation of the Bazaar, a virtual marketplace for ingame goods, the Tunnel of Ro became a rare place to find players.

The Tunnel of Ro lost its purpose, as the Bazaar featured an out-of-game selling system as well. Due to the lost interest of players in the Tunnel of Ro as social meeting place, the neighboring continent (the East Commonlands) became a much less popular zone to be in. It appears that the need for relatedness was no longer satisfied in the Tunnel of Ro and the East Commonlands due to the absence of trading possibilities, and thus, other players.

The Tunnel of Ro, exemplifies the value of parallel play as means to satisfy needs for relatedness. In school environments, parallel play is usually easily accomplished, since students are educated together in one classroom. Despite the motivational value of parallel play, its impact may be minimal. However, this can be increased through *gameplay sharing* and the development of (social) *interdependence*.

Figure 100:A Mage (Damage Dealer), Warrior (Tank) and Priest (Healer) in World of Warcraft

Social interdependence

Social interdependence is predominantly found in MMORPGs. It suggests that players need one another to overcome obstacles or fully enjoy the game. For example, interdependence in *World of Warcraft* (Blizzard Entertainment, 2004) is based on a 'rock-paper-scissors' principle. This design pattern (Bjork & Holopainen, 2004) is based on a triage formation, in which every actor is dependent (or has a weakness) on another.

The triage relationship can be found in *World of Warcraft* classes. The game posits roles (or classes) to characters. Groups of classes that are highly depending on one another are comprised of a Damage Dealer, Tank, and Healer. The Tanks taunt a foe and keep it away from the Damage Dealer and Healer. The tank can take many hits before dying. Tanks have strong defensive capabilities, but their offense is considerably weaker. The healer keeps the tank alive by casting healing spells. Although this prolongs the lifespan of a tank, the damage to the foe remains minimal. It is the Mage who 'deals the damage'. Since a Mage cannot wear any defensive armor, the tank is charged with the responsibility to keep the foes away from the Mage. As a result, players heavily depend on one another in a rock (tank) paper (healer) scissors (damage dealer) formation.

Social interdependency as discussed above has a strong externally regulating association. If players do not work together harmoniously, their quest will likely fail. Hereby players are punished for not relying on one another. However, players can choose which role they play and with whom they wish to explore the abilities of this role. Moreover players can circumvent the interdependency rule in *World of Warcraft* in many ways. Raiding with Mages only is definitely an option in the game. Players just need to coordinate their attacks in a different way. As a result, players can play in a way that suits their interests, therefore expressing and exploring their identity.

On top of the various playing styles in *World of Warcraft*, the way to reach a goal in the game makes sense. It is logical to assume that a huge dragon cannot be taken down by a mere priest or warrior. Combining forces is therefore a reasonable decision to accomplish the goal. Because of the relevance of the situation and the possibilities to play in one's own way, the design tool of social interdependency can result in an identified regulated experience.

Gameplay sharing

Sharing Gameplay can be considered a way to satisfy needs for relatedness in a way that corresponds both to identified and integrated regulatory experiences. Gameplay sharing can be accomplished in various ways. This section discusses several ways to share gameplay and connects every manner to a particular regulatory skill. Starting with the least autonomy-supportive sharing of gameplay: high-score lists.

Players share the outcome of their game to express their game play abilities and to relate their ability to others. Pinball machines can be considered the first game cabinets to adopt high-scoring lists (DeMaria & Wilson, 2003). In 1979 game developer Exidy launched *Star Fire*. *Star Fire* is one of the first arcade games equipped with a personalized high score list. From then on, posting one's high scores slowly gained popularity. Not only arcade hall players shared their accomplishments; also home-console players started to share their high-scores. To prove one's high score, gamers photographed their high scores, and sent the picture to a magazine. In turn, the magazine published the high score in its next issue.

The last forty years show a transition from sharing high scores (mechanics) to sharing gameplay (dynamics). This transition illustrates a change in possible experienced Regulatory Style as well. Namely from external regulations (scoring and achievement systems) to identified and integrated regulations (sharing ways to play and new games).

For example, children of the Dutch television show *AllesKits?* could participate in a game contest. Using the digits on their phone, participants played a game of *Tetris* (Nintendo R&D1, 1989) that was broadcasted live on TV (the Spelefoon). The week's high score players were invited to race each other in an 'on-tellie' competition of *Super Mario Kart* (Nintendo EAD, 1992). In this way players started to share more than their scores - they started to share how they played the game. They started to share gameplay.

Finally, the user-generated gaming platform *Little Big Planet 2* (Media Molecule, 2010) elevates social negotiations about dynamics even further. Not only can players enjoy the games designed by other players, they can actually construct their *own*. This results in heated debates about the gameplay of user-generated games, and an intense amount of appraisal of other players' games.
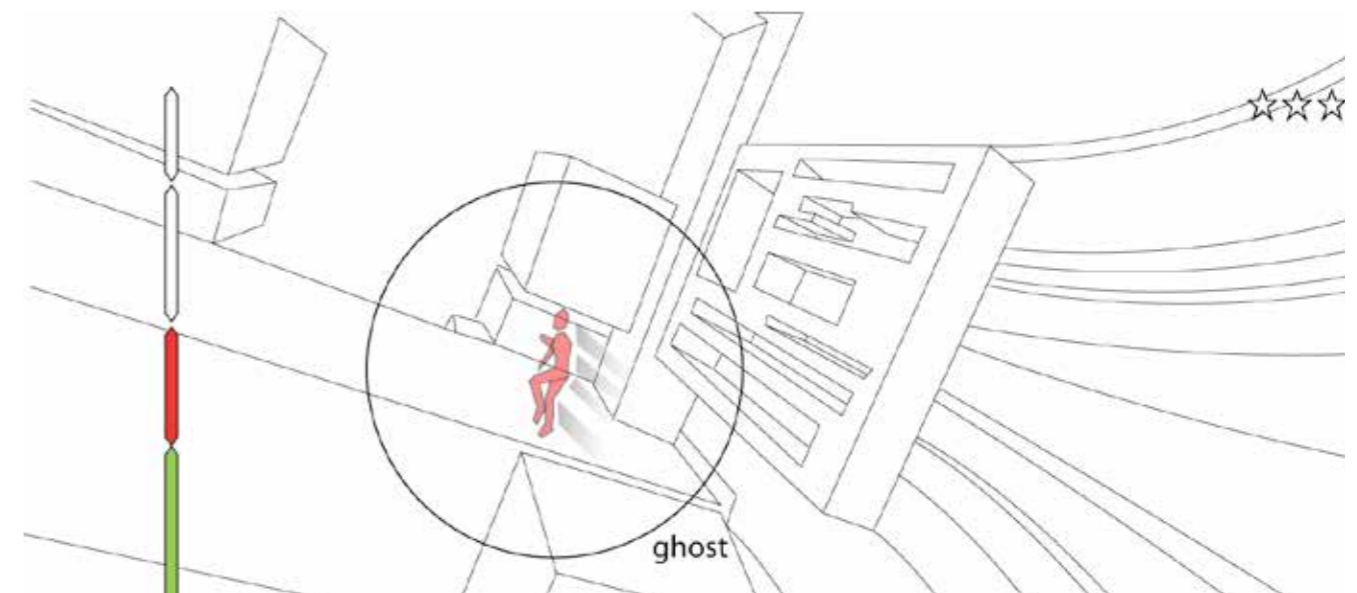
The sharing of gameplay is becoming increasingly self-expressive and personal. Players are increasingly able to identify with the games in a rich variety of ways and express themselves to others. As a result, social negotiations between players are becoming increasingly meaningful. Whereas high-score lists and play-recordings of competitive games mainly stimulated debates about players' competencies, sharing gameplay through parallel play and social interdependency have been enriched with new ways to play and sharing user generated games to incite social negotiations between players.

The transition from sharing high-scores to games and play-sessions suggests a transition from external regulations to identified regulations. The sharing of play-sessions to actual games suggests a transition from identified regulations to integrated regulations. The use of identified and integrated regulations to satisfy needs for relatedness may strengthen motivation during play. The three tools; 1) parallel play, 2) (social)interdependency, and 3) Sharing Gameplay, may prove valuable to designers whom wish to develop autonomy-supportive games that facilitate the internalization of learning regulation to the self.

The ability to record and review play sessions appears rather engaging. Game designers recognized this, and created software to record complete play sessions for the benefit of play-training. Racing games especially are known for their ability to record play sessions. For example, *Super Mario Kart* offers gamers the opportunity to race their 'ghost' in a time trial. Consequently other genres like *Action-adventures* (*TombRaider [N-Gage edition]* (Core Design, 1995)) offered players the possibility to share their speed run. Sony's Playstation 4 is even equipped with a gameplay share button, in which players can broadcast their play session to others. These build forth on popular television channels and websites like twitch.tv (Justin.tv, 2011) that broadcast play sessions of high-end players.

Satisfying needs for autonomy

According to Self-Determination theory, the third universal human need is the need for autonomy. Autonomy suggests that people experience an internal locus of causality (DeCharms, 1968). This means that individuals feel that they, themselves, are responsible for their actions (and the possible outcomes that transpire). The 'cause' of what transpires is largely depicted by individuals themselves (internally) and not because of others (external enforcements). If an activity presents individuals with a certain responsibility and influence, it supports individuals' autonomy, and is therefore considered 'autonomy-supportive'. It will become clear that play is a very autonomy-supportive activity.

The more players can play in a game, the more players may feel autonomous. Play can be characterized as a restructuring practice (Deen & Schouten, 2010). Restructuring suggests the rearrangement, alteration or manipulation of existing configurations of the 'existing' to create something new. Restructuring practices are clearly witnessed in games like *MineCraft* and *LittleBigPlanet* (Media Molecule, 2008). In these games, players can rearrange existing game objects, rules, and environments to create a new game.

The autonomy-support found in a sand-box game like *MineCraft* is less apparent in more compliant games such as *Super Mario Bros.* or *Mass Effect 3*. Here players have less restructureable elements at their disposal. Thus, games offer various degrees of restructuring practices. Therefore, games present various degrees of autonomy-supportive activities. The Circle of Restructuring Practice by Deen & Schouten (2010) illustrates the different levels of restructuring practices in games. Since play is considered an autonomous activity, restructuring is considered an autonomous activity as well. This means that the Circle of Restructuring Practices presents various levels of autonomy-support in games.

The circle makes a distinction between constructing practices and restructuring practices. Constructing suggests that something is created from scratch. Like a painting on an empty canvas, the game is developed without any game elements in place. The game designer started with a clean sheet and authors the first steps in game development. Then degrees of more / less autonomy-support through restructuring practices are discussed along two lines.
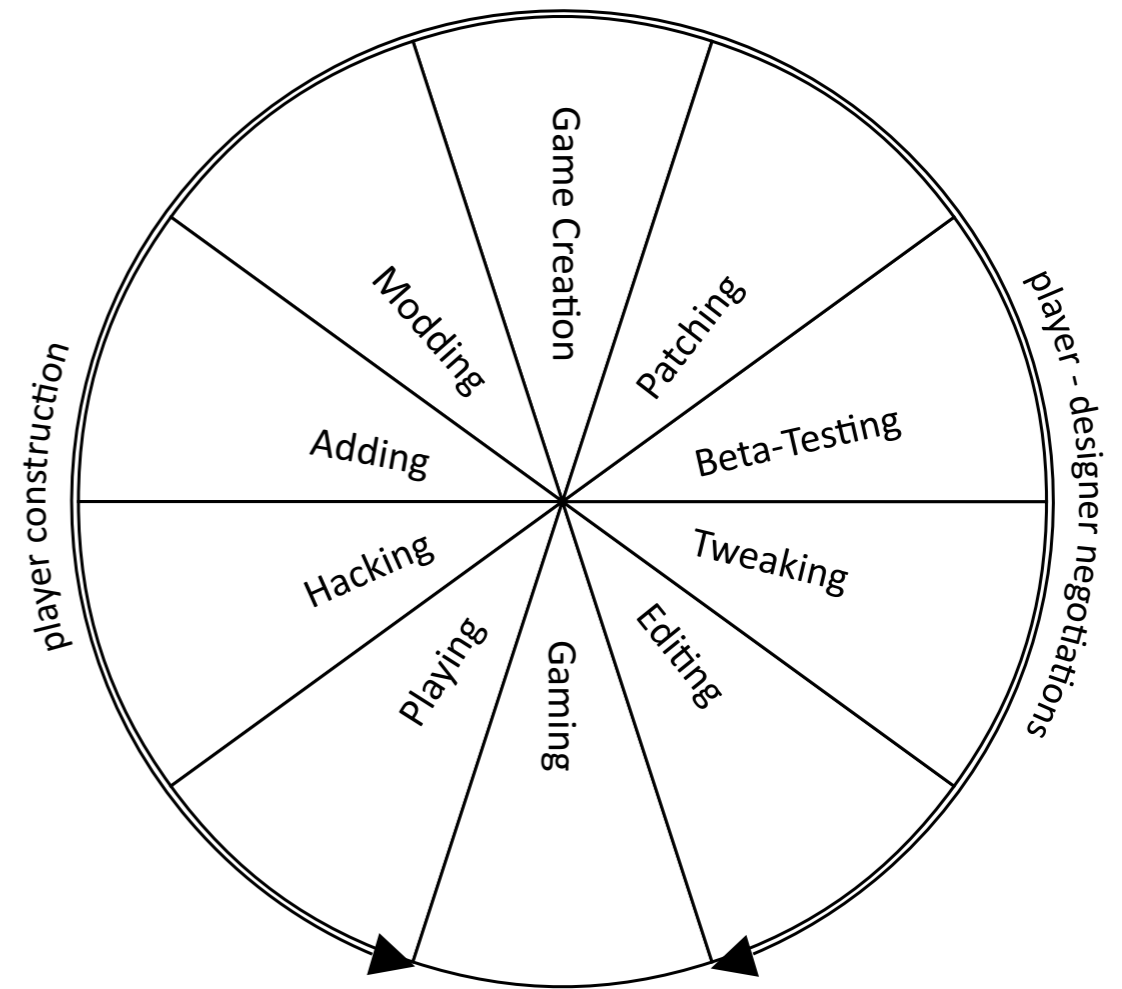
On the right side it follows the increase of autonomy-support for players by designers. The game design practices discussed on this side of the circle mainly focus on social negotiations between players and designers. It will become clear how games become more autonomy-supportive when the designer abdicates more authorship towards players.

The left side of the circle presents the game design practices that mainly originate from players. When a game is released, gamers start to explore its boundaries and possibilities. The player construction side of the circle illustrates this process, in which players increasingly claim authorship over the original game, creating their own autonomy-supportive environments.

Patching
Initial creation of a game is considered more authored than patching. Patching describes the process of making alterations to existing games. For its greater part, patching is made possible by the connectivity of the internet. Blizzard Entertainment (2004) releases monthly patches for the MMORPG *World of Warcraft*, in which the differences between classes are changed, bugs are fixed and some significant rules are altered.

An example of a significant change or patch of game mechanics is the Drop-Rate alteration in *World of Warcraft.* In this MMORPG, gamers loot items from defeated foes. Which item is looted depends on the foe and on loot-probability. For example, a common item may drop one out of six tries. Players expected that the items would drop more easily after repetitive killings. In practice this does not happen. Loot-probability is based on change; some players kill numerous foes without looting a particular item, while other players loot the precious item after their first fight. In response to players' looting-expectations, Blizzard created a system in which the drop-rate increased every time a foe was killed (i.e. from 1:6 to 1:7 after 8 kills). So, the more foes killed, the more likely players are to loot an item.

By adhering to players' expectations and implicit theories on calculating change, the designers made it easier for players to identify with the gameplay. In turn, players may feel more in control over their actions, since the reaction they receive is what they expected. This creates a greater sense of autonomy, especially because players may feel that they had a say in the change. But it goes without saying that patching can backfire too. If done incorrectly (thus, not connecting to the implicit theory of players), they may take away the personal causation of players, and thereby autonomy.

Beta phase
By restructuring game mechanics in monthly patches, mechanics become debated between players and designers. Social Games, like *FarmVille* (Zynga, 2009-2011) or *Happy Island* (CrowdStar, 2010-2011), build forth on this iterative design process. Apparently, these Social Games never leave beta phase (i.e. the development stage of a production cycle). Instead, Zynga changes the mechanics in almost real-time to satisfy immediate needs and actions of the player community.

Blizzard, Zynga and CrowdStar do not only change the rules, they add new objects, administer environmental changes, and even present gamers with new goals to accomplish. Social Game designers carefully analyze the players' actions and participate in game-forums to accommodate the player's expectations. While the time span is shortened in comparison to patching, it is still the game designer who authors the changes instead of the players themselves.

Beta phase development corresponds to recent developments in crowd funding. On websites such as KickStarter.com or IndiGoGo.com visitors can fund a game development program. Depending on the amount of funding, future players have a say in the development cycle. In the KickStarter project of Double Fine Studios, for example, players could even become a character in the game. Still, it is the game designer who authors the changes.

More so than in patching, players may feel that they have a say in the iterations (read, restructuring) of the game by the developers. Players are actively invited to report bugs, gameplay issues, and are invited to fill in questionnaires. Being part of beta testing, players may feel respected, and may feel that their input matters. As a result, their locus of causation may become more internal, making them feel more autonomous.

Tweaking
The same is true for tweaking. Tweaking is the possibility of making small changes to game mechanics, which may significantly influence the gameplay. An example of tweaking can be found in *Mass Effect* (BioWare, 2007). Gamers can choose to improve the abilities of the game character, which in turn will change the play experience. Players can choose to act politely or ruthlessly. This changes the narrative of the game and its sequels. Tweaking parameters are common to many RPG-like games, but are found in other genres as well.

The fighting game *Super Smash Brothers Brawl* (Sora, 2008) offers parameters that slightly change (e.g. tweak) the brawls. Amongst others, gamers can tweak the amount of power-ups, add multiple characters, limit play opportunities per character, or change the time limit. Although gamers are given more freedom to tweak specific rules in the game, the game designer authors the parameters. If players are particularly skilled in programming, they would be able to hack the game, change other parameters, and create new games.

Not all players possess the programming skills to make alterations in the source code. In some games, programming skills are unnecessary to create a personal game. In *WarioWare D.I.Y.* (Nintendo & Intelligent Systems, 2009) players can create their own *WarioWare*-minigames. *WarioWare*-minigames are based on tapping or flicking the *Nintendo DS stylus* on a specific point, or in a particular way, within a certain time limit.

WarioWare D.I.Y. players can change an extensive number of parameters (graphics, time, number of tabs, flick gestures, sounds, etc). Still, the game does not offer the construction of new games. Gamers merely edit typical *WarioWare* games. As a result, the gameplay remains essentially similar to other *WarioWare* titles. In other words, *WarioWare D.I.Y.* corresponds to the restructuring qualities of 'level editors'.

Editing
Level editors are available for an extensive number of games. They present players with the opportunity to create their own game levels[1], racing tracks[2], battling stages[3], cars[4] or characters[5]. Still, the addition of a level editor may not offer players the possibility of restructuring the actual game mechanics. Most of the time, edits concern environments and objects, not the rules and goals of a game. Moreover, edits are less about restructuring, and more about constructing instead.

A level editor is to a game as a text editor is to an ebook. By writing fan fiction, readers are not playing with the initial text, but readers are playing with the theme, characters, timeline, or environment of the original story to create something new. By reading a book, readers cannot rearrange sections or sentences to change their meaning. That is because a printed text in itself is unchangeable.

Like tweaking, level editors offer players a direct and hands-on experience for changing the game in the way they like to play it. It is clear that players can do more in level editors than they can do when tweaking the game. Nonetheless, both offer more restructuring practices, giving players more room to put in 'something of themselves' and thereby satisfying needs for autonomy.

Modding, adding and hacking
Without an editor, gamers can only comply or deviate from pre-configured mechanics. Nevertheless, some gamers change more than the aesthetics and dynamics alone. Modders and Hackers actually restructure existing games and reconstruct them to their personal liking.

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1   *LodeRunner* (D. E. Smith, 1983), *StarCraft* (Blizzard Entertainment, 1998).
2   *Stunts* (Distinctive Software Inc., 1990).
3   *SuperSmashBrothers Brawl* (Sora, 2008).
4   *LEGO Racers* (High Voltage Software, 1998).
5   *World of Warcraft* (Blizzard Entertainment, 2004).

Figure 107: In Stunts players can create a race-track themselves

Figure 108: Many players developed their own levels. This is Rats a huge kitchen where player can fight each other

The word Hacker "describes in computer culture a person with sophisticated programming skills developing creative solutions to complex and challenging problems." (Scheäfer, 2008, p. 29.) Many hackers develop add-ons or cheat programs for games (Consalvo, 2009). Some players create complete new games based on the original games' engine. They modify the game until it fits their desires.

A stunning example of gamers utilizing their programming or artistic skills to 'mod' an existing game, and construct a rich and playful experience in accordance to their personal likings, is *Half-Life: Counter Strike* (Le & Cliffe, 1999). Le & Cliffe changed the one-player first person shooter *Half Life* (Valve Corporation, 1998) into a multiplayer game that became so successful that it was prepackaged with the original game.

Sihvonen (2009) studied the Modding scene and found that modders do not only play the games, they play *with* the games. Sihvonen describes how players modified *The Sims* (Maxis, 2000) to create their own narratives, game world and games.

Playing / restructuring
Creative outlets, similar to the Modding community, are recognized in the game *Little Big Planet* (Media Molecule, 2008). In contrast to *WarioWario D.I.Y.*, *Little Big Planet* players are not confined to tap and flick mini-games. Instead, players are encouraged to use the objects in *Little Big Planet* to create their own rules, goals and environments.

Players can even upload personal imagery into the game, and alter visualizations and characteristics of objects and environments. *Little Big Planet* offers players many restructuring possibilities without the need to learn a programming language. Its flourishing community, with more millions of uploaded levels, high praise from both gamers and game critics, and the sale of more than three million copies, prove that the game has a huge appeal to the gaming community.

Still, *Little Big Planet* remains a level-editor for the majority of gamers. It is hard to create other games than platformers. Its successor, *Little Big Planet 2* (Media Molecule, 2011), changed this. By adding building blocks with simplified artificial intelligence, Media Molecule made it easier to create new games by using the *Little Big Planet 2* tools. Interestingly, the game designers of *Little Big Planet 2* claim that they themselves have no other tools at their disposal than those available in the game editor.

Little Big Planet 2 players created astonishing replicas of innovative games such as *Flower*[6] (thatgamecompany, 2009) and *fIOw*[7] (Chen, Clark, & Wintory, 2006). Media Molecule facilitated a play-experience that is as rich, diverse and communicative as children's play. Since designers and players have the same tools at their disposal to create games, game designers and game players are 'equals' in their restructuring abilities.

Another game that is interesting in regard to facilitating restructuring practices is *MineCraft* (Persson, 2009). Persson offers players an environment with an extensive amount of building blocks, a day and night cycle, and various inhabitants (cows, sheep, and spiders during the day, and wandering zombies at night). Players can harvest resources by cutting down trees, digging up mountains and shaving sheep. By harvesting resources players literally take away the building blocks of the environment and rearrange them to construct something new. *MineCraft* is often depicted as a virtual LEGO playground. However, in comparison to analogue LEGO units, the digital *MineCraft*'s resources are given various abilities, opening even more possibilities for restructuring practices.

This richness of interactive building units in *MineCraft* becomes clear in the rich variety of constructions developed. *MineCraft* players restructured rather spectacular environments, from complete replicas of *Star Trek's Enterprise NCC-1701*[8], to working 16bit CPU's[9].

Additionally, *MineCraft* players created their own games as well. One of them is *Spleef*. In this game players stand on a platform that hangs high in the sky. The goal is simple: Make players fall off the platform by destroying the platform. The catch is, you are on the same platform and the only way to destroy the platform is by harvesting it.

In theory, games like *Little Big Planet 2* and *MineCraft* can be restructured in very rich ways. Thanks to being a virtual objects, they can contain unending combinations of functionalities. *MineCraft*'s resources only hint to the restructuring possibilities of virtual environments. The strong focus on, and the many possibilities of, restructuring both the games' environment as the game itself makes *MineCraft* a very autonomy-supportive game.

6   To see *Flower - Little Big Planet 2* in action see GQuater (2010).
7   To see *fIOw - Little Big Planet 2* in action see ChimpanzeePS3 (2010).
8   To see *Enterprise – MineCraft* in action check MozzieMineCraft (2010).
9   To see *CPU – MineCraft* in action check theinternetwtf (2010).

Figure 109: Minecraft – a working calculator

Figure 110: Little Big Planet 2 offers players various ways to create their own game Students

Amount of restructuring and degree of autonomy-support
The circle of restructuring practices illustrates how various degrees of autonomy-support appear to coincide with the amount of restructureable elements in game. It appears that the more players can restructure, the more autonomous the game seems to become. When designers wish to create an autonomy-supportive game for learning the circle may help them to pinpoint which game-aspects could increase or decrease the degree of autonomy-support offered.

8.5 Satisfying competence autonomy & relatedness

Needs for competence, autonomy and relatedness can be satisfied in various ways. Identified regulation may prove a feasible approach for serious games to satisfy these needs. It is suggested that the needs can be satisfied by:

1. The design of a Zone of Proximal Development (competence).

2. Presenting players with Progressive Feedback (competence).

3. Design for Parallel play (relatedness).

4. Create a social interdependency amongst players (relatedness).

5. Offer ways to share gameplay with others (relatedness).

6. Offer a particular amount of restructuring practices (autonomy).

This list is not exhaustive, but came into being by relating insights from developmental psychology (social constructivism and problem-based learning), with game theory (play as restructuring practice), and theories on human motivation (Self-Determination Theory). If serious game designers wish to adhere to the Integrated Design Approach (Habgood, 2007), they can utilize the above design tools to increase motivation to play.

The next section will describe how the above list can be used as guideline to increase motivation in a serious game with educational purposes.

9

GUIDELINES TO INCREASE MOTIVATION

Parts of this section are based on:

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches.* IGI Global.

- Deen, M., Schouten, B., & Bekker, M. M. (Tilde). (2011). Playful Identity. In J. Reasens (Ed.), . Utrecht: Utrecht University.

SECTION 9 **DESIGN GUIDELINES**

The Integrated Design Approach, as put forward by Habgood (2007), suggests that games can increase students' motivation if the learning activity corresponds to the gameplay. This thesis brought forward a way to bring the learning into congruence with the gameplay (see section 4). The first part of The Applied Game Design Model explains how designers can create a game in which students actually play with the learning content. Additionally, thoughts from Self-Determination Theory (Ryan & Deci, 2000) were discussed to further pin-point a direction for motivational game design.

Ryan & Deci (2000) claim that motivation to engage in a particular activity can be increased if people feel *competent*, *autonomous* and *related* to significant others when they engage in the activity. This section will explain how game design suggestions in section 8 can be utilized in practice. The practical implications of these design directions are illustrated by the development of *Combinatorics* (Deen & Verhoeven, 2011).

The game *Combinatorics* (Deen & Verhoeven, 2011) plays with the mathematical principle of calculating possibilities. This activity often preludes the calculation of change. Reichard *et al.* (2003) explain this counting activity with traversable pathways. For example, if people wish to travel from La Palma to Gran Canaria, there are various routes to get there. Figure 112 shows a route map of the possible paths to take. In this example, one can traverse through (3 x 3 x 4 =) 36 routes to get from La Palma to Gran Canaria. Travelers can take three routes from La Palma to La Gomera, _and_ three routes from la Gomera to Tenerife, _and_ four routes from Tenerife to Gran Canaria. Students need to multiply the amount of routes to arrive at the correct answer of 36 possible routes.

If students travel from Tenerife to Fuerteventura, they can take the southern routes: four routes from Tenerife to Gran Canaria, _and_ two routes from Gran Canaria to Fuerteventura, _or_ one route from Tenerife to Fuerteventura. In total these are (4 x 2 + 1) = 9 different routes from Tenerife to Fuerteventura. The main rule of this counting exercise is that _and_ is multiplying and _or_ is summation.

Figure 111: Fontys ICT working on Combinatorics, from left to right: Bram Vermeulen, Fabian op den Camp, Dennis Lemmen, Arie Gijsenbergh, and Eric van Gastel.

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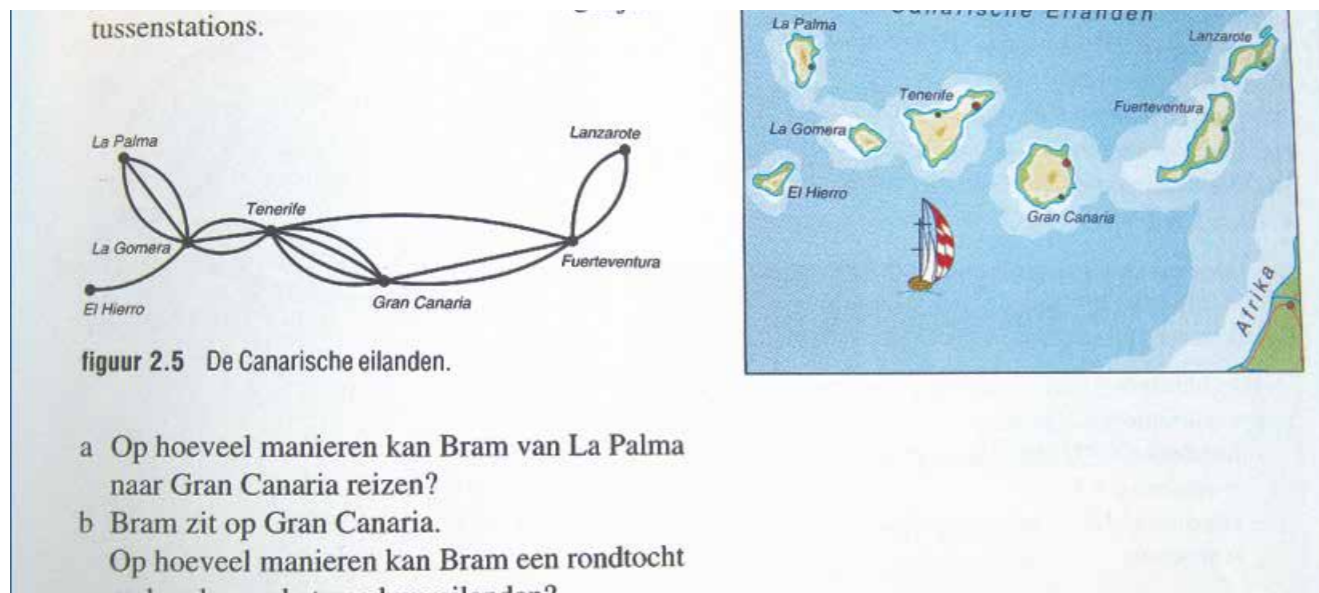
In *Combinatorics*, the metaphor of the islands was replaced by cells that traverse from point A to point B. Every time the cell enters an intersection it multiplies in accordance with the number of branches. Figure 113 shows how the cell multiplies by the number of intersections. The cell travels through an intersection, then a three-way junction, followed by an intersection, then another three-way junction: This means 2 x 3 x 2 x 3 = 36 possible routes.

Combinatorics offers two modes to play. The first mode is the Drill & Practice mode. It situates various roadmaps that grow more complex by the progression of levels. Players are asked to count the number of possible routes that exist in every roadmap. In the Drill & Practice mode, players can only give one correct answer; they are nudged and instructed towards correct performance and conceptual mastery.

The other mode is called the Autonomy-support mode. In this mode players are given a number of possibilities and an unfinished roadmap. Players are tasked with reverse engineering the solution to create a roadmap that accounts for the number of possibilities given. In this mode, players can restructure existing roadmaps by exploring, experimenting, and struggling with the learning procedure. Because of the more restructuring activities (in comparison to the Drill & Practice mode), this mode is considered autonomy-supportive.

The theories anchor the design decisions of *Combinatorics*:

1) **Gameplay as restructuring practice** (Deen & Schouten, 2010): Designers can search for the restructureable and fixed elements in learning to initiate their design process.

2) **The Integrated Design Approach** (Habgood, 2007): Gameplay equals learning activity.

3) **Social Constructive thoughts** on learning (Vygotsky, 1978): Learning environments can increase motivation if they are autonomy-supportive.

4) **Self-Determination Theory** (Ryan & Deci, 2000): Motivation can be increased if needs for competence, autonomy and relatedness are satisfied.
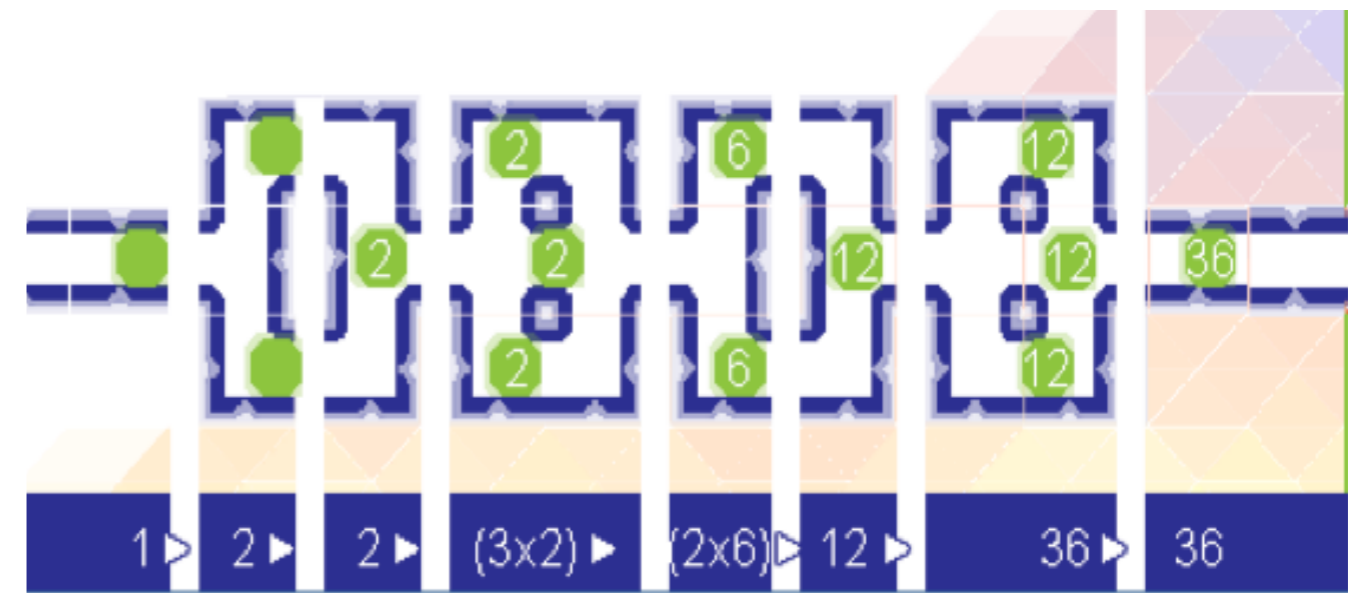
This section mainly focuses iImplementing thoughts of Self-Determination Theory. More precisely, it will explain how needs for competence and autonomy relatedness can be satisfied. This section shows how the Zone of Proximal Development, parallel play, and gameplay sharing can satisfy these needs in a way that corresponds with identified and/or interjected regulations.

The section will start with satisfying needs for competence through the means of building a zone of proximal development. It will explain how designers can break down the learning content into manageable pieces that are only a little above students' cognitive level within an autonomy-supportive way of learning. Following the satisfaction of needs for competence, the needs for relatedness are addressed by the means of parallel play and gameplay sharing. The sections will discuss pros and cons of the autonomy-supportive approach, concerning the design process of *Combinatorics*. The last section will illustrate the design process of implementing various playing styles, ways to offer multiple solutions to a problem, and the design for a Regulatory Fit. All these design decisions build toward more autonomy-support.

9.1   Zone of Proximal Development

A carefully designed increase in difficulty settings can educate players in a particular subject and/or skill. By breaking the content into manageable pieces that are only a little above students' cognitive level, students may gradually learn without too much effort. The Zone of Proximal Development suggests an environment in various learning paths (or scaffolds) to choose from. As a result, students can self-determine what to develop and when.

In *Combinatorics* (Deen & Verhoeven, 2011), the level of progression follows the scaffolded steps of the course book *Numbers & Spaces* (Reichard et al., 2003). As such, every level introduces a new learning issue to resolve, building forth on knowledge gained in the preceding levels. At first, we considered forcing players to finish a level before progressing to the next. This way, we could reasonably assume that players learned enough to overcome the next challenge. However, students would not be able to self-determine their path, and as such it did not feel very autonomy-supportive.
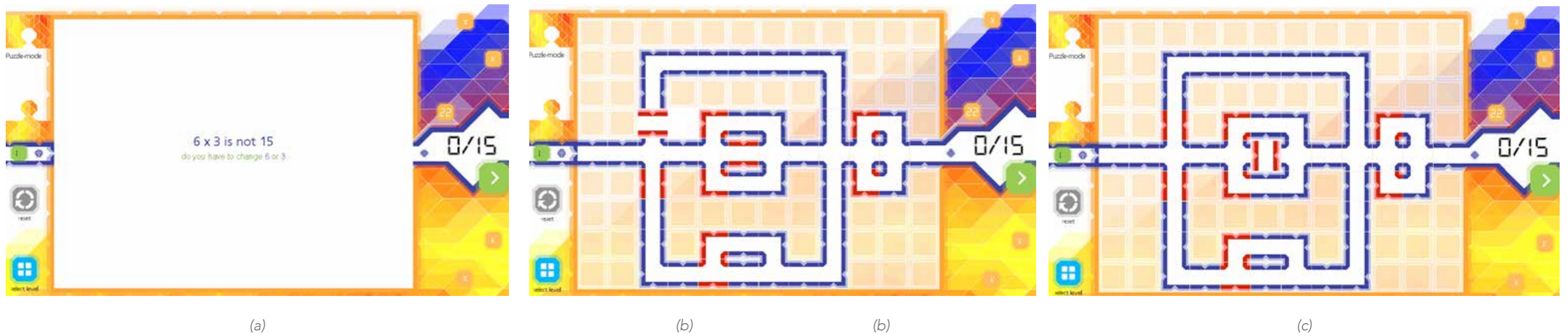
(a)   (b)   (b)   (c)

We had to design for a Zone of Proximal Development to satisfy needs for competence and autonomy. The examples of the Zone of Proximal Development in section 2 concern the vast free-roaming world of *World of Warcraft* (Blizzard Entertainment, 2004). In comparison, *Combinatorics* is a small game with little room for 'world-exploration'. In order to translate the free-roaming aspect of the vast open world to the limited space of *Combinatorics*, we adapted the Advent Calendar Method of Progressive Feedback. Instead of enforcing players to progress through levels before progressing to the next, we opened up all levels to the players. The 'level select' screen presents. the levels, categorized by difficulty level and numbered accordingly. All levels are open to players. As a result, students could self-determine which level they wished to play.

During user tests we found that players 'self-imposed' regulations. Some played the higher levels first, only to find out that they did not understand what the game was about. After a couple of futile tries, they started with level 1 and progressed gradually through the game. They followed the levels as designed by us, and replayed a level until they got it right. We did not force them to do so, we merely suggested an ideal learning path. This was a very simple way to present players with the opportunity to generate their own path through the game.

9.2 Parallel play and gameplay sharing

Parallel play and gameplay sharing are two ways to satisfy needs for relatedness in an autonomy-supportive game. Parallel play is the most easily designed, especially when the game concerns a classroom exercise. In classrooms, students are already positioned next to one another and they are performing the same learning activity.

Although students played their own game, they frequently helped others out, expressed their progression in the game to their peers, and asked others for help when stuck. In order to elicit these rich social negotiations about the learning content, students should be allowed to talk aloud, and see others' screens and progress. This means that teachers should allow students to talk during class.

Figure 114: Level 22 offers multiple solutions to one challenge. From left to right: a) a short hint about the challenge

Figure 115: b) rotating the road-tile closes the uppermost route, now there are fifteen routes possible, c) rotating the center road-tile also creates fifteen routes

Another way to elicit gameplay sharing practices is by offering a level editor, and the ability to share user-generated levels with others. We found that players seldom played around in the editor, and even fewer students created a complete level that could be shared. The short timespan (approximately thirty minutes) of play-sessions may account for this issue. Additionally, the level editor presented players with an empty field and unlimited amount of roadmap tiles. As a consequence, the editor was more about constructing than restructuring, suggesting it was not playful or inviting to get into.

9.3 External and identified regulations

External regulations can control and steer behavior. This can be useful in the short run, especially for instructive practices and informative use. For example, in *Braid* the first levels introduce jumps and time-reverse mechanics in a straightforward manner before opening up the game to players. In *Combinatorics* we used external regulations to quickly explain the basics of the game and the learning content. The first levels are rather straight forward and do not offer multiple solutions to one problem. Additionally, when a puzzle is not solved, players can only replay the level or go back to the level select screen. Players are only 'rewarded' with the next button if they successfully complete a level.

Higher levels align more identified regulated experience. However, every time a new mechanic was introduced we used utilized external regulations to quickly explain the mechanic (or learning content). This thesis describes three ways to design for identified regulations: 1) Offering various Playing Styles in one game; 2) creating multiple solutions to challenge; and 3) designing for a Regulatory Fit.

9.4 Playing styles

Implementing various playing styles in a game can be accomplished in various ways. Section 4.2 already elaborated upon four playing styles: theoretical, pragmatic, interpersonal and self-expressive styles of play.
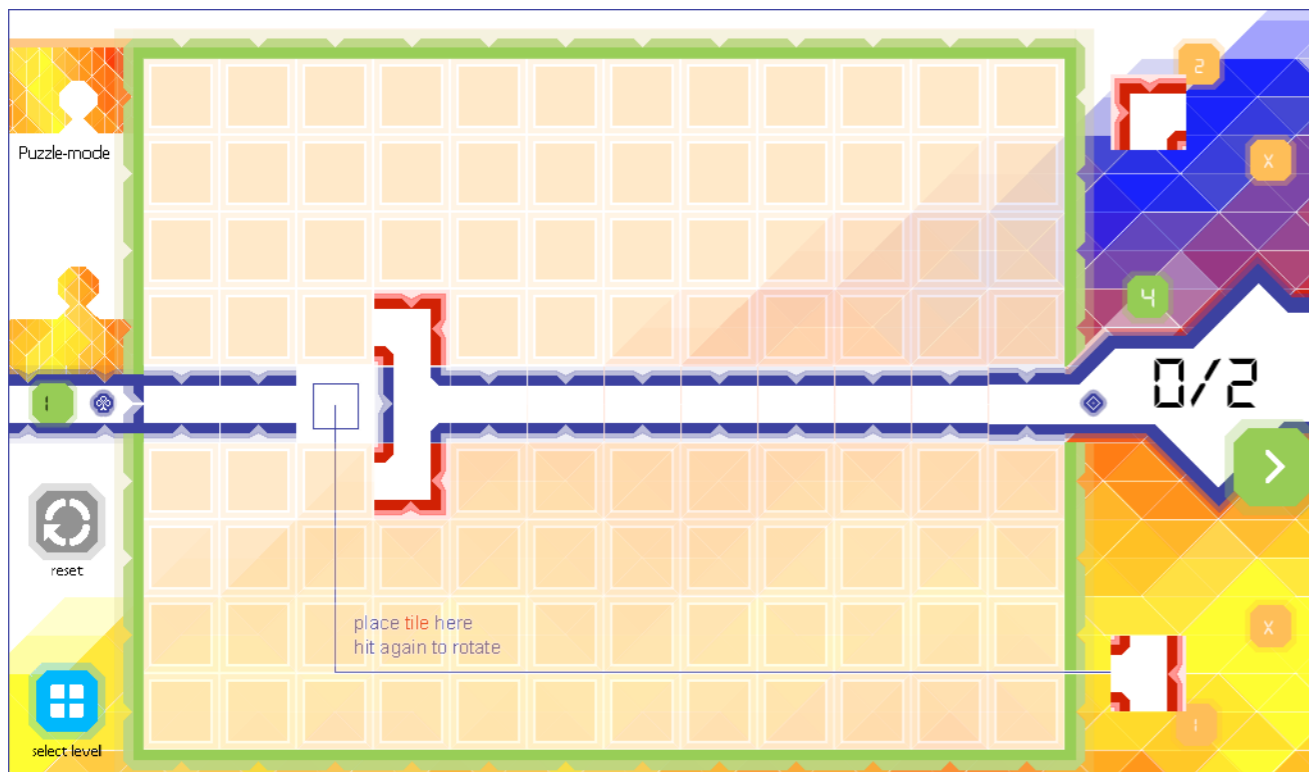
Theoretical players may enjoy reflective and instructive explanations about the game's premise. Theoretical players like to consult external recourses. The course-book: *Numbers & Spaces* (Reichard et al., 2003) appears well designed as reference material for theoretical players. It may prove useful to make actual references to the book in the game for extra reading. What's more, theoretical players enjoy exploring data sets. Mining metrics during play, and presenting these to players, may give them a better insight in the learning procedure.

In *Combinatorics*, theoretical players were addressed by the correspondence of the game with the course-book. The course-book was used as a template to scaffold the learning in the game. Students played the game after completion of the chapter 'smart counting'. This way, students already had a theoretical construct about the *And&Or-rule*. What's more, instructional and reflective texts nudged students into a possible answer to the challenge, helping them to construct a conceptual model of the mathematics.

Pragmatic players search for hands-on experiences. Thanks to the opportunity to restructure various elements in the game, this group of players is partly catered for. These students learn by trial and error. This means that it is easy to impede their style of play through the design of restriction. For example, the utilization of time limits, a maximum number of opportunities to complete a level, or the design of scoring systems that favor 'one-hit-solutions' will impede pragmatic learning, since they do not foster trial and error learning, but favor a more theoretical approach instead. It is therefore suggested to leave these external regulations out of the design process.

Pragmatic players appeared rather well addressed by *Combinatorics*. One of the math-teachers casually reported that she was happy to see her female students adopting a Trial & Error way of learning. She connected this change in strategy to the advance of smartphones amongst youngsters: "They learn how to try-out new things on a smart phone, and in this game, they can do the same for maths." she suggested.

The game does not enforce a learning style that asks for pre-flection (reflective actions that occur before a particular assignment or activity has begun (Slavich & Zimbardo, 2012). Players can replay a level, as many times they prefer. However, in order to minimize 'button mashing' (or a 'blind finite state machine that can beat the game' (Nelson, 2011, p. 17)) we introduced cell animation. This animation takes time, in which players interactions are limited. Since pragmatic players typically do not enjoy waiting, they will probably figure out the right answer before reviewing the animation.

Self-expressive players enjoy cheating. This may feel controversial; but this thesis suggests that designers should allow students to cheat. Circumventing the rules is one of the great pleasures of self-expressive players. Dubbed 'Killers' by Bartle (1996), self-expressive players search for loopholes in the game to exploit. Finding loopholes, Easter Eggs and game bugs asks for real commitment to the game since they build upon players' need for game capital (Consalvo, 2009). Players have to really get into the game to find ways to cheat the system. In other words, if you want to bend the rules, you have to first learn how to play them.

The restructureable activities of *Combinatorics* are elaborated upon in section 6. Self-expressive players may enjoy the construction of new roadmaps and the level-editor. Also, the bug proved a valuable instrument to adhere to the self-expressive approaching style. When players complete a roadmap, a small animation plays. During this animation the number of possibilities is 'calculated' by the game. Players could intervene in this animation by closing or opening a road during the counting process. As a result, they could fool the system. Students who found the bug were reasonably proud about their accomplishment, and did not hesitate to express their insights to other students. However, we found that players did replay the level 'the right way' after encountering the bug. Still, its discovery appeared highly engaging to some.

Interpersonal players have a need for social negotiations through and during play. The classroom setting itself addresses the social negotiations during play. Peers and teachers can exchange thoughts about the learning. Note that speaking must be allowed for these social negotiations to take place. Classrooms in which speaking is not permitted may impede interpersonal learners motivation significantly.

The bug provoked debate about the validity of the game, and about the way it should be played. Interpersonal students helped one another out by pointing each other in the right direction. A teacher remarked about one student: "Normally her interest is somewhere else completely. Now she is even explaining the mathematics to her friends".

9.5 Multiple solutions

In mathematics the process to the answer can be regarded more valuable than the final answer itself. However, games like *Math Gran Prix.* (Atari Inc., 1982) or *Monkey Tales: Monkey Labs* (Larian Studios, 2009) favor correct answering over the mathematic process. They offer players little room to create their own solution to a problem. There is only one way to calculate a particular exercise. This may limit students' willingness to experiment or explore the mathematics, since the answer is already there.

Today's game industry is embracing the thought that games can offer many different ways towards a singular goal. Some games even offer various goals to accomplish. By doing so, players are given more freedom to self-stipulate how to get from A to B. This way of learning can be found in Open Games (Harpstead, MacLellan, Aleven, & Myers, 2014; Harpstead, Myers, & Aleven, 2013) such as; *RumbleBlocks* (Christel et al., 2012), *SimCityEDU* (GlassLab, 2013) and *Go Vector Go!* (BrainPOP, 2014). These games offer multiple solutions to the challenges presented, creating more diverse ways of play.

In *Combinatorics* some levels offer more than one solution. For example, in level 22, players can rearrange a roadmap to create fifteen possible routes. By rotating a straight road-tile, a route is closed. Rotating the road-tile in Figure 115 b closes the uppermost route. Now there are fifteen routes from left to right. However, rotating the center road-tile (see Figure 115 c) creates fifteen routes as well. There are multiple solutions to one question in level 22.

9.6 Regulatory Fit

The above guidelines may present game designers with clear guidelines to design autonomy-supportive games. However, graphical designers may be at a loss as how to contribute to the visual representation of educational practices. Especially since Habgood et al. (2005) proved false Malone's (1981) suggestion that fantasy (i.e. visual correspondences to myth and folklore) is an intrinsically motivating feature. This means that game designers cannot fall back on 'typical' game culture fantasies; science fiction, myth and folklore. Instead, they are challenged to find a context or visual style that resembles the learning subject matter.

It remains unclear what 'tone' graphic designers can set to increase students' motivation to learn. Bianco et al. (2003) and Higgins (2000) may offer an elegant solution this problem called Regulatory Fit. A Regulatory Fit suggests that developers create a correspondence between students' implicit theory of the instruction, and the actual tone of instruction. In game design terms: The graphic style and gameplay corresponds to the players' expectations. In order to design a Regulatory Fit, designers could interview students about their implicit theory of the learning procedure. When designers do not have access to students, other good indicators are teachers and/or domain experts.

When the implicit theory is made explicit, designers could create a mood board to inspire design processes in a particular direction (Lucero Vera, 2009). The mood board consists of pictures that correspond to the implicit theory of the target audience. Designers can 'borrow' elements from these pictures in the game's graphical interface. As such, the mood board steers the tone of the game, and thus, the tone of instruction that may correspond to students' implicit theory. Ideally, the mood board would be co-created or presented to the targeted audience. Note that the mood board does not represent the targeted audience, but it suggests a possible interpretation of students' implicit theory about the learning.

In order to design a Regulatory Fit in *Combinatorics*, we interviewed alumni students of HAVO 4 about their implicit theory of mathematics and counting problems. Students of *Fontys School for ICT* were asked how they perceived their early mathematic classes, and what concepts came to mind when they thought about calculating numbers of possibilities.

Figure 117: Mood board about Combinatorics

Most students depicted mathematics as something abstract, filled with geometric shapes, diagrams, and squared paper. Colors that came to mind were primary (red, yellow and blue), complementary (orange, green, and purple) and clean whites. Mathematics was something that appeared difficult, but once you got it, it was easy to understand.

The construct of *Combinatorics* appeared closely related to the idea of exponential growth, little multiplications that make up for large numbers, tree diagrams, and gambling. With these elements in mind, a mood board was created. In Figure 117 the mood board is presented. Note the primary colors, geometric shapes and gambling attributes. The digital clock was added to communicate that little objects can create diverse and large numbers of possibilities.

Before students were consulted, a mock-up game was already in development. The design was quickly done in Adobe Photoshop to present the programmers with something more to work with than mere tech-art. As can be seen in Figure 118 (left), this design was a sketch that mainly explored the usability of the interface. Clearly, the game addressed a thematic issue that did not fit the mood board above. This design was too 'mechanic-like'. The design of Figure 118 (right) adheres more to the mood board. It explored the use of digital-clock elements, primary colors and tree-structures in the interface.
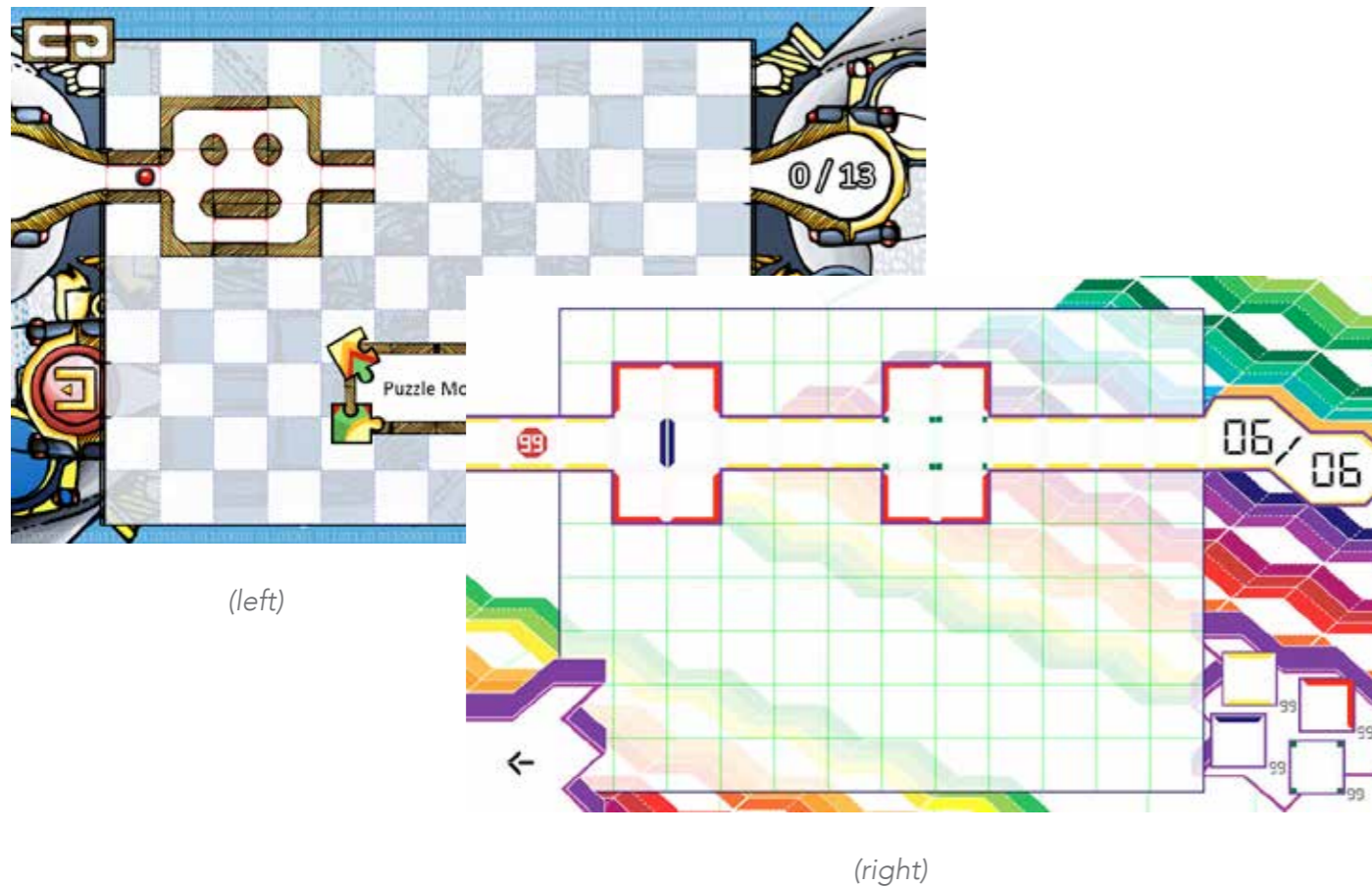
(left)

(right)

The final design is presented in Figure 116 on page 170. The digital clock elements are used more extensively in this version. Boarders, font, buttons, and tiles all relate to digital clocks. By overlaying primary color trees, a rich pallet of colors emerges, suggesting again how little rules can make many differentiations.

The final design corresponds with the initial mood board. This way the tone of instruction may fit the implicit theory students have about the learning, namely the idea of exponential growth through small rules, clear colors and geometric figures.

9.7   Summary

Designers can satisfy needs for competence and relatedness in this autonomy-supportive environment by using design tools such as the Zone of Proximal Development, parallel play and gameplay sharing. The design for a Regulatory Fit can set the right tone for the game. As a result, the game may better correspond to the expectations of students about the learning and increase motivation to learn.

Combinatorics illustrates this design process by breaking down the learning content to one procedure: The And&Or-rule. Consequently, the restructureable elements were defined. Road-tiles appeared the most interesting elements to play with, and as such a game was developed in which players could restructure various roadmaps to accommodate a specific number of routes. *Combinatorics'* graphic style may correspond to students' implicit theory, and its autonomy-supportive design may resonate with adolescents' heightened need for autonomy. In the next section we will study the quality of these design guidelines upon students' motivations to learn.

10

THE MOTIVATIONAL IMPACT OF *COMBINATORICS*

Parts of this section are based on:

- Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven: Leuven University.

- Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches.* IGI Global.

- Deen, M., & Schouten, B. A. M. (2014). The differences between Problem-Based and Drill & Practice games on motivations to learn. Presented at the International Academic Conference on Meaningful Play, East Lansing.

Figure 119: An early poster on the study on Combinatorics

SECTION 10 VALIDATION

We witness two trends in educational game design: a Problem-Based Learning approach and a Drill & Practice Training approach. Problem-Based education has been put forward as 'the way to go' in educational game design by Aldrich (2009) Gee (2005). According to the scholars, this educational approach appears the 'best fit' when it comes to creating educational games. In comparison, more traditional training regimes, called Drill & Practice learning, may proof less effective in a game when it concerns students' motivation to learn.

The differences between above learning approaches in games are seldom studied. That is why this study examined two modes of the game *Combinatorics* (Deen & Verhoeven, 2011), 1) a Problem-Based playing mode, and 2) A Drill & Practice gaming mode. The problem based mode presents players with an ill-defined problem and offers various solutions to a challenge. In the Drill & Practice mode there is only one correct answer.

The research question is: *how does a problem-based mode and a Drill & Practice mode of one educational game influence the experienced regulatory style of students towards mathematics education*

This study examined the reported change in motivation amongst students directly after playing one of the two game-modes. It used the Academic Self-Determination Questionnaire (Ryan & Connell, 1989) to qualify motivational change in experienced Regulatory Style. This means that motivation can be expressed in the way someone feels regulated instead of stating that motivation is high or low. For example, someone who feels controlled and pushed by others to engage in an activity will feel externally regulated. In contrast, someone who engages in an activity because the activity in itself is satisfying will feel intrinsically regulated.

The Academic Self-Regulation Questionnaire assessed the reported Regulatory Style before and after playing *Combinatorics*'. Students (n = 105) played the game for twenty-five minutes and were already familiar with this aspect of mathematics. Therefore, the game fitted their curriculum and could build further upon their knowledge. Results suggest that both modes have a different effect on students' experienced Regulatory Style. This article describes these differences and suggests a possible explanation.

10.1 Participants

The study sample consisted of 105 Dutch students of which 105 students (45 boys, 60 girls) completed both pre- and post-test. All students shared their fourth year classes of Senior General Secondary Education (HAVO). A HAVO diploma provides access to a BA level of tertiary education. The participants were aged 15 to 16 years.

Participants take courses in economics, languages, and arts. The mathematics course is mandatory, since the course-subjects are complementary to the other courses. Amongst others, topics they cover are analytics and probability calculations. As a result, students were familiar with the basic concept of *Combinatorics*. The study sample was not drawn randomly but conveniently sampled: the school participated voluntarily.

The students were not randomly assigned to a different condition. An earlier study (Deen, 2009) tough us that awareness amongst students that other groups were performing in different (maybe more favorable) tasks elicited feelings of jealousy. In order to avoid this possible effect on students' motivation we assigned parallel classes to different conditions.

10.2 Materials

Participants either played the Problem-Based (n = 62; 30 girls) or Drill & Practice mode (n = 43; 30 girls) of *Combinatorics* (Deen & Verhoeven, 2011). They completed an adapted version of the *Academic Self-Determination Questionnaire* (Ryan & Connel, 1989) before and after playing the game. In the questionnaire, the words 'school work' were changed into 'mathematics exercises' and the survey was translated to Dutch. The survey was conducted through *LimeSurvey* (Schmitz & Cleeland, 2003) during school-time in the classroom.

Drill & Practice mode
The Drill & Practice mode corresponds to rather traditional educational exercises, in which students need to repetitively complete (drill) specific exercises to learn the mathematical principle by heart. The Drill & Practice mode focuses on the transfer of content knowledge and the training of specific skills. These games/exercises typically present learners with a question with only one outcome.

Figure 120: Play-Sessions at MetaMeer College (left) and Heerbeeck College (right)

This Drill & Practice mode guides players towards applying the And&Or Rule successfully. The challenges have only one correct answer and the mode offers players few opportunities to change anything else but the answer. This type of training differs significantly from problem-based learning method in *Combinatorics* (see Figure 123 on page 181).
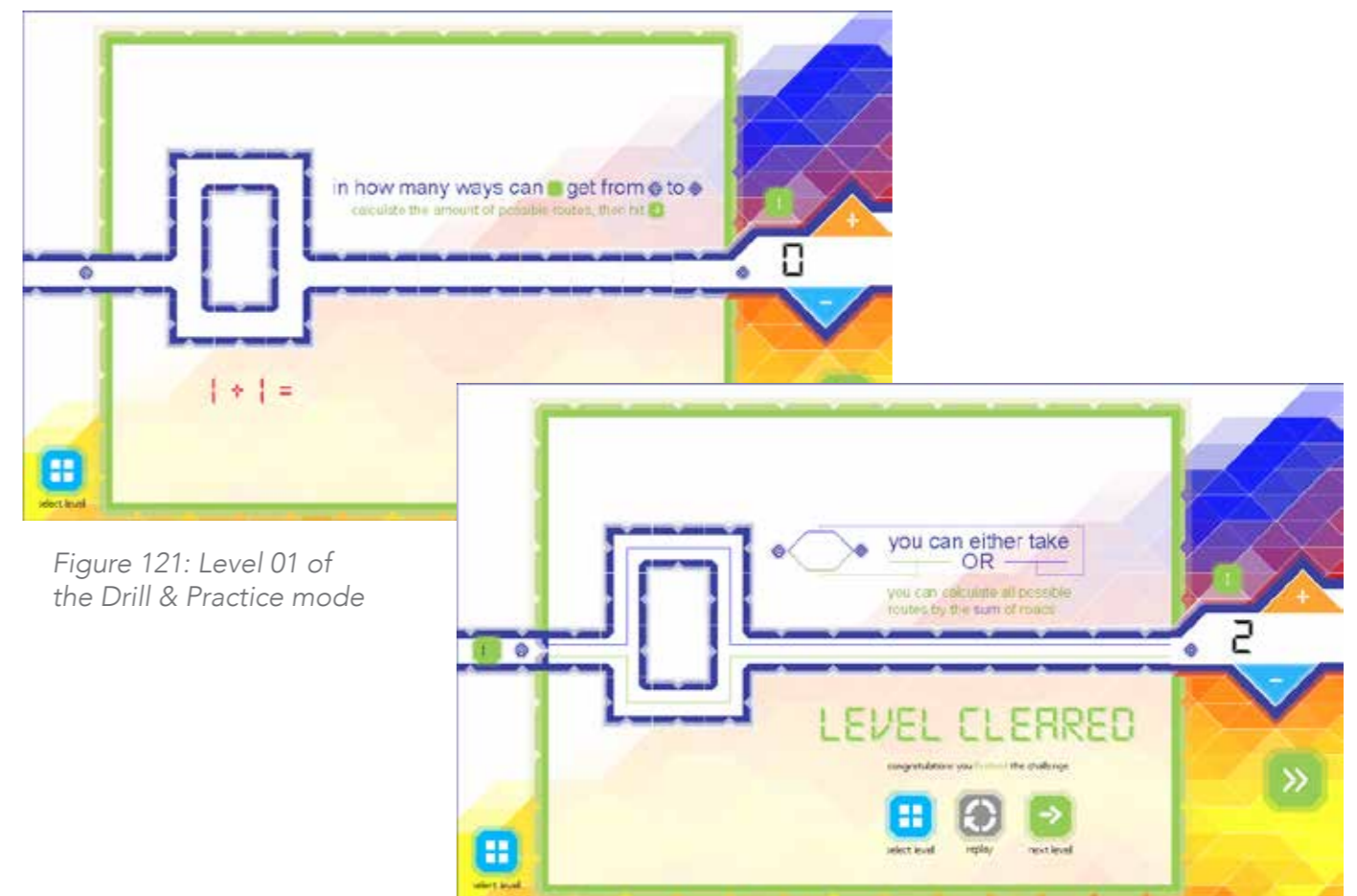
Figure 121: Level 01 of the Drill & Practice mode
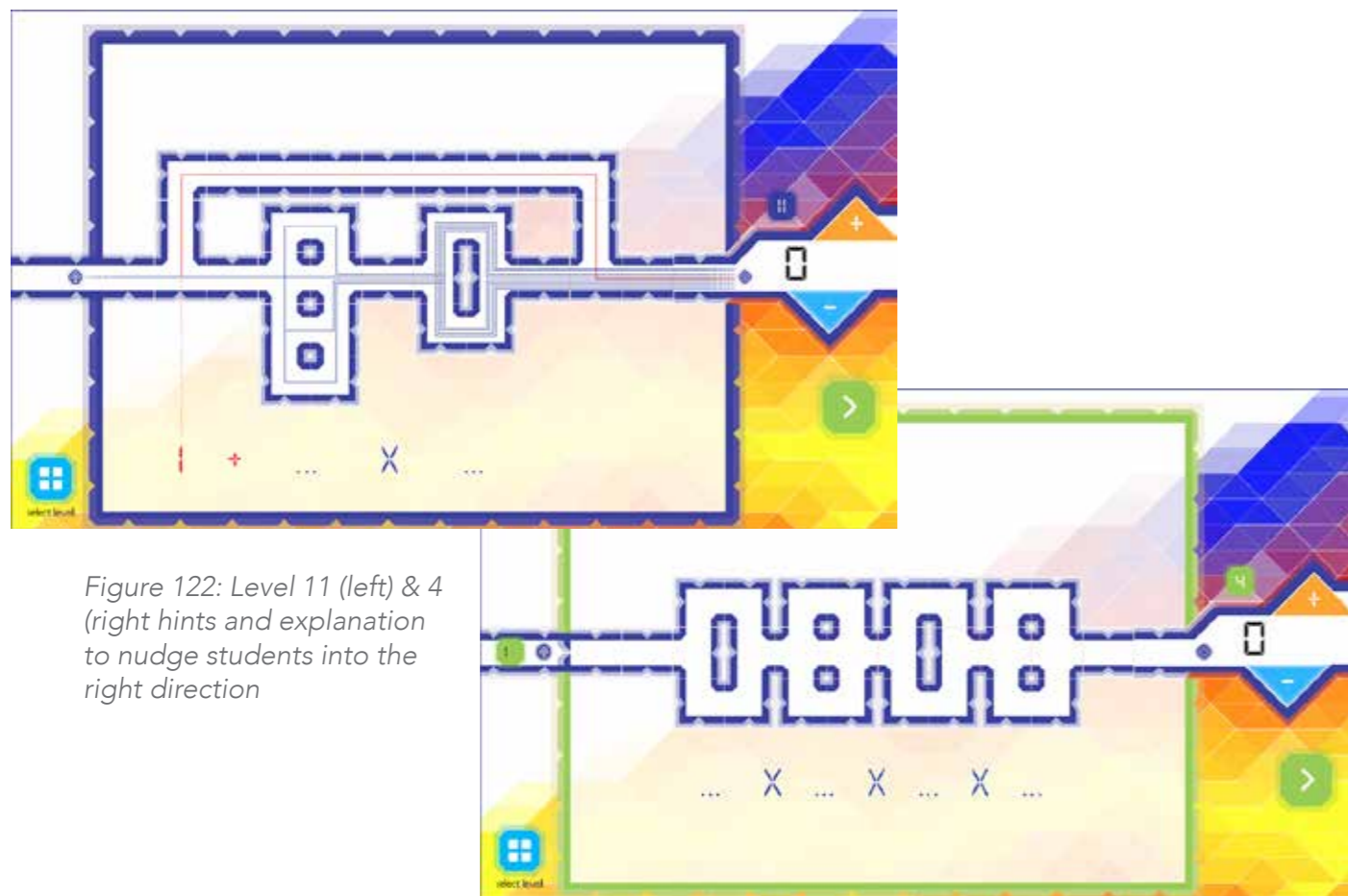
Figure 122: Level 11 (left) & 4 (right hints and explanation to nudge students into the right direction
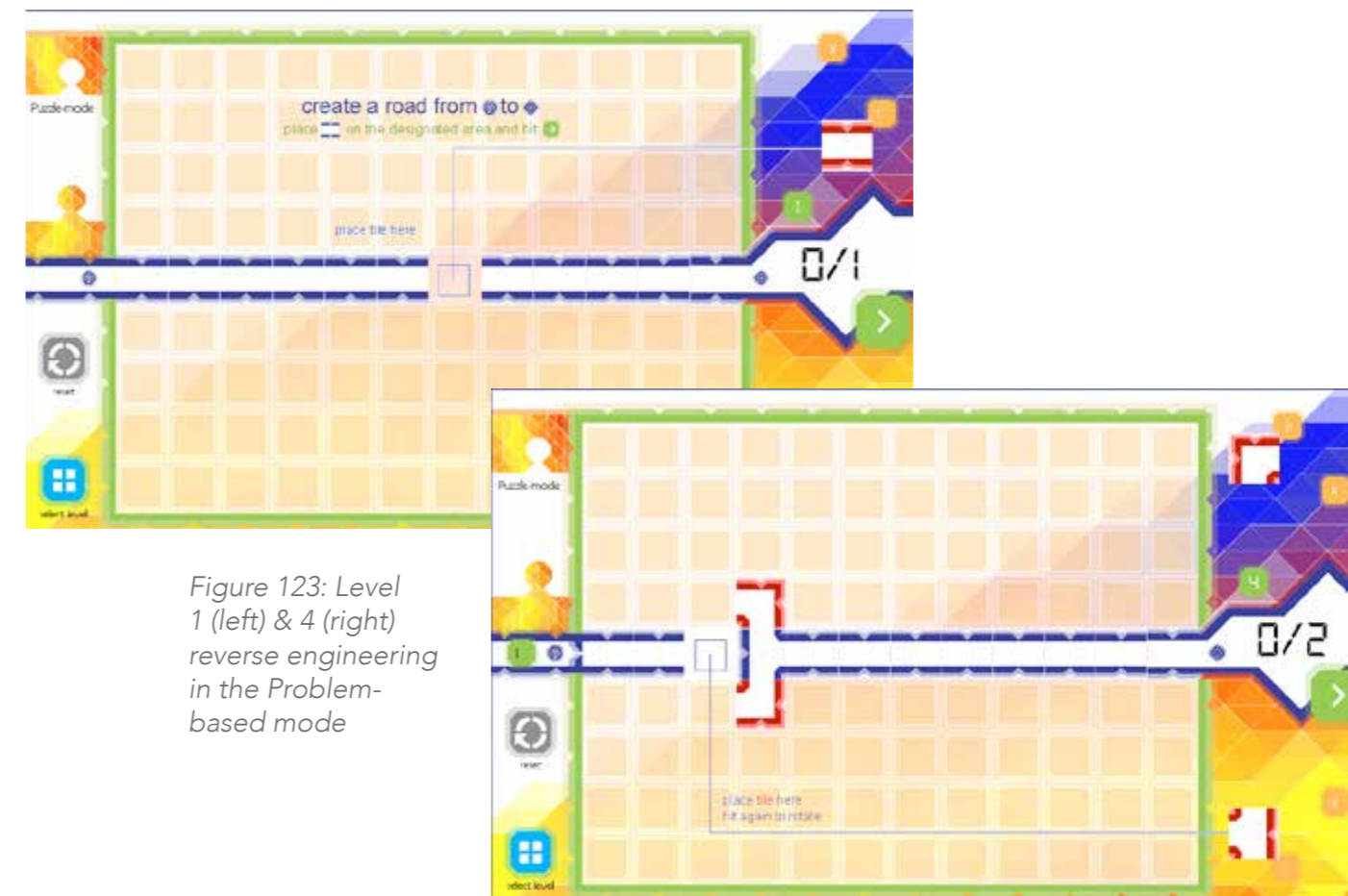
Figure 123: Level 1 (left) & 4 (right) reverse engineering in the Problem-based mode

Problem-based mode

For the Problem-based mode we focused on presenting players with an ill-defined problem and offering various solutions to the problem. The mode asks players to 'reverse engineer' a solution by restructuring an existing roadmap (see Figure 123). In this game mode the number of possible routes is given. Players need to *restructure* the roadmap in order to produce the given number of combinations. Players can *explore* and *experiment* with the rearrangement of road-tiles. These road-tiles function as straight road, corner, 3-way junction and intersection. Road-tiles can create a roadmap.

In Figure 123 (left), players can 'fix' a roadmap by placing a straight road-tile on the empty spot. In level 01, fixing the roadmap makes for 1 possible route. In level 04 (right), players learn to place a 3-way intersection and two corners to create a roadmap that accommodates for two possible routes.

Some levels offer more than one solution. For example, in level 22, players can rearrange a roadmap to create fifteen routes. By rotating a straight road-tile, a route is closed. Rotating the road-tile in Figure 124 (left) closes the uppermost route. Now there are fifteen routes from left to right. However, rotating the center road-tile (see Figure 124(right)) creates fifteen routes as well. As a result, there are multiple solutions to one question in level 22.

Academic Self-Determination Questionnaire

The 32 statements of this questionnaire were rated on a four point Likert-scale (1 not at all true, 2 not very true, 3 sort of true, 4 very true) to indicate the reasons for pursuing mathematics learning activities. For example, participants were asked for the reasons to do classwork. High scores on statements such as 'So that the teacher won't yell at me' or 'Because I want the teacher to think I'm a good student' suggest that participants felt *externally* or *introjected* regulated to perform in mathematics education.

10.3 Procedure

The timespan between pre- and post-game test was deliberately short to measure the direct impact of the different game modes on participants' experienced Regulatory Style and to minimize the amount of dropouts. Participants completed the pre-test in 10 minutes. They played the Problem-Based mode or the Drill & Practice mode for approximately 25 minutes, and completed the post-game test immediately afterwards.
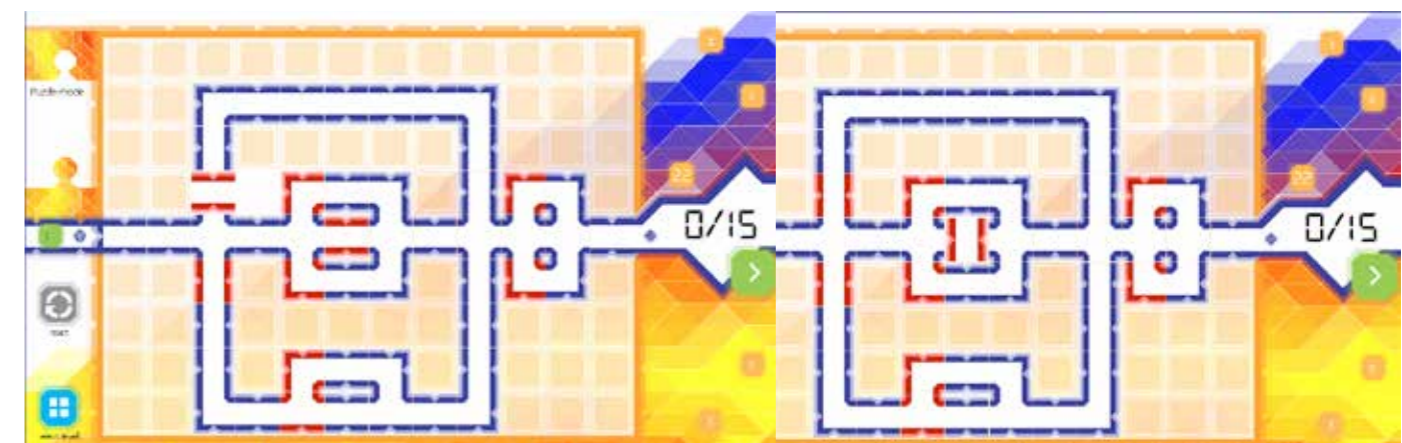
Figure 124: Level 22 offers multiple solutions to one challenge.

	Drill & Practice N = 43		Problem-Based N = 62	
	Mean	(SD)	Mean	(SD)
External Reg.	0.064	(0.263)	0.103*	(0.272)
Introjected Reg.	0.008	(0.229)	0.059	(0.254)
Identified Reg.	-0.007*	(0.245)	0.067	(0.304)
Intrinsic Reg.	-0.100*	(0.266)	0.055	(0.232)

*Table 3: Mean differences (and SD) Drill & Practice mode and Problem-Based mode. Paired samples t-test; * p<.05, 2-tailed significance. Scores on 5 point Likert scale. Negative mean difference indicates an increase in regulation score.*

	Pre-game test MS	DM	Post-game test SD		95% CI for Mean Difference	t
External Reg.	2.63	0.38	2.56	0.50	-0.02, 0.15-	1.60
Introjected Reg.	2.05	0.35	2.04	0.42	-0.06, 0.07-	0.23
Identified Reg.	2.66	0.55	2.65	0.59	-0.07, 0.08-	0.18
Intrinsic Reg.	1.70	0.35	1.80	0.45	-0.18, -0.182	.47*
RAI	-1.240	.96	- 0.911	.03-	0.56, -0.102	.89*

Table 4: Descriptive statistics and t-test results for regulations in Drill & Practice mode *p < .05; df = 42.*

	Pre-game test MS	DM	Post-game test SD		95% CI for Mean Difference	t
External Reg.	2.69	0.36	2.58	0.45	0.03, 0.172	.99*
Introjected Reg.	2.08	0.50	2.02	0.58	-0.06, 0.121	.82
Identified Reg.	2.84	0.40	2.77	0.55	-0.01, 0.141	.74
Intrinsic Reg.	1.83	0.47	1.77	0.51	-0.00, 0.111	.87
RAI	2.69	0.36	2.58	0.45	0.03, 0.17-	0.91

Table 5: Descriptive statistics and t-test results for regulations in Problem-Based mode *p < .05; df = 61*

10.4 Analysis

In this study, pre-game test/post-game test scores on the SDT-scales (External Regulation, Introjected Regulation, Identified Regulation, Intrinsic Regulation and the Relative Autonomy Index) were compared in Problem Based Mode and Drill & Practice Mode by using a paired-samples t-test. The effect size estimates (p < .05) were calculated with the statistical software package SPSS-18.

10.5 Results

The results presented in Table 3 compare reported in changes in Regulatory Style for the Problem-Based mode players and Drill & Practice mode players. It presents the mean differences between reported change in Regulatory Style for Problem-Based mode players (n = 62) and Drill & Practice mode players (n = 43).

Three significant changes were found (marked with an *). Findings suggest a significant increase in reported intrinsic regulations (0.100), and self-determined learning (0.329) for Drill & Practice Mode players. Additionally, Problem-Based Mode players reported a significant change in experienced external regulations. These appear to decrease with 0.103 points.

Drill & Practice
Findings of the Drill & Practice mode indicate a significant difference in the scores between pre- and post-game test Intrinsic Regulations and RAI-scores.

· Pre-game test Intrinsic Regulations: M=1.70, SD=0.35.

· Post-game test Intrinsic Regulations: M=1.80, SD=0.45.

· Pre-game test RAI-scores: M= -1.24, SD=0.96.

· Post-game test RAI-scores: M= -0.91, SD=1.03.

The mean for Intrinsic Regulations varied between 1.70 and 1.80 (SD = 0.39) see Table 4. This implies that students answered with 'not at all true' and 'not very true' to statements concerning intrinsic motivation for mathematics. The increase in intrinsic regulations suggests a mood-change from 'not at all true' to 'not very true'.

Problem-Based
Problem-Based mode findings suggest that the mode has a positive effect on students' motivation to learn. Students appear to feel less controlled by their environment (e.g. rewards and punishments from others) to engage in mathematics. Problem-Based mode players reported a significant difference in:

· Pre-game test External Regulations: M=2.69, SD=0.36.

· Post-game test External Regulations: M=2.58, SD=0.45.

The mean scores for external regulations range from 2.58 to 2.69, suggesting that participants answered 'true' for most external regulated statements in the questionnaire (Table 5). In comparison to the Drill & Practice mode, findings for RAI-score and intrinsic regulations were not significant.

10.6 Discussion

Overall, players of *Combinatorics* reported increased self-determined engagement in mathematics learning (this is suggested by the increased RAI-score) after playing the game. Closer analysis of the impact of the two different game-modes on experienced regulations suggests that both modes have a different impact on students' motivations to learn. The Drill & Practice mode players reported an increase in intrinsically regulated and RAI score. The Problem-Based mode players reported a decrease in external regulations.

It must be noted that the time between measurements was deliberately short to decrease dropouts amongst participants and to decrease other external influences. The questionnaire is, however, primarily used to give insights in motivational change over a longer period of time. The short term effect observed in the current study must therefore be considered with caution, since it can be related to player enjoyment, novelty of a game in the classroom, or influences from external researchers during play sessions. Nonetheless, the results show a significant mood-change that asks for further research and development.

Drill & Practice

The increase in intrinsic regulation for the Drill & Practice mode can be explained by the concept of Regulatory Fit (Bianco et al., 2003). The Drill & Practice mode creates a Regulatory Fit between the learning method of the game and the learning method of course-books. Since students are accustomed to this kind of learning, the correspondence between learning methods may ease the integration of the learning regulations to the students' self. In short, a Regulatory Fit may account for the increase in reported intrinsic regulations.

It appears that Regulatory Fit transcends the tone of instruction and can relate to teaching *style* as well. Within this perspective, the Problem-Based mode may feel too 'game-like' to students and to less 'education-like'. The prospect of exploring, experimenting and struggling with mathematics may not fit students' implicit theory about mathematics-education, since students may be unaccustomed to the teaching model of the facilitator. Therefore, students may have difficulty relating to the new learning method.

Another explanation for the increase of intrinsic regulations is that the Drill & Practice game mode focuses on the skill mastery and correct performance. The Drill & Practice mode presents players with direct feedback on learning progression. The direct feedback makes students more aware of their progress. This way, the mode appears to satisfy needs for competence, which is one of the universal human needs described by Ryan & Deci (Ryan & Deci, 2000). According to Ryan & Deci, if needs for competence are satisfied, participants' motivations to engage in the activity may increase.

Problem-Based

The decrease in external regulations for the Problem-Based mode can be explained by the restructuring possibilities offered by this mode. Problem-Based players of *Combinatorics* could restructure the learning content: players could actually change something in the game (more than only the puzzle's answer). Additionally, the game mode offered multiple solutions to one problem. As a result, participants may have felt less restricted and enforced. This feeling may transfer to participants' expectations of future learning activities, which may explain why participants report to feel less enforced by their environment to engage in mathematics education. It appears that a game in which players can restructure facets of the learning content may lower feelings of externally regulated learning.

10.7 Conclusion

This study examined the mean differences in reported Regulatory Style experiences towards mathematics learning of students after playing a Drill & Practice or Problem-Based version of the mathematics game *Combinatorics*. Two significant findings appear useful to educational game design: the increase of intrinsic regulations for Drill & Practice games, the decline in external regulations amongst Problem-Based players.

It is suggested that the increase of intrinsic regulations amongst Drill & Practice players may be caused by a Regulatory Fit between students' implicit theory of learning mathematics and the learning method presented. Furthermore, the decrease in external regulations amongst Problem-Based mode players may be caused by the possibility to generate one's own path to solutions, and the opportunities to restructure (i.e. play (Deen & Schouten, 2010)) various aspects of the learning content.

We think that Problem-Based learning games could kick-start innovative learning approaches, like social constructivists learning, by offering novel learning methods. One of the teachers suggested that serious games could break down barriers for her 'weird' learning methods. These 'weird' learning modes were social constructivist and autonomy-supportive in nature.

Combining both modes into one game may prove a fruitful approach to increase the integration of learning regulations to the students' self (satisfying both needs for competence as autonomy). Future research may study the way in which this combination could be implemented and validated.

It is safe to state that games can effect motivation differently. It cannot be assumed, as Prensky (2006) did, that games naturally correspond to students' daily life. Instead, debates about games in the classroom should include in-depth analyzes of the learning-method offered by the game and take students' implicit theory about learning style into account. In the future, if schools adopt social constructivist learning approaches, students may have less difficulty to relate to this novel approach to playful learning.

11

DISCUSSION

**CONTRIBUTION, POSITIONING
& FUTURE RESEARCH**

This section discusses how the contributions of this thesis can be positioned within the wider field of academic research on game design and game development practices. Additionally, it discusses various thoughts on future research to autonomy-supportive game design. The three main contributions that are discussed are:

Play as restructuring practice

Practical guidelines for game design

Autonomy-supportive games

Additionally the implications of the Applied Game Design Model are discussed thoghout the sections.

11.1 Restructuring

This thesis' main contribution is that it describes a change of perspective towards serious game design, namely envisioning play and learning as a restructuring practice. While the formal game design approach focused on rules and regulations, this approach is more activity-centered, focusing on process and style. This may help designers to integrate the learning into the gameplay and leverage the motivational potential of games.

The characterization of play as a restructuring practice is one of the few attempts in academic research to characterize the activity of play instead of focusing on the emotional responses that emanate from the activity. Huizinga (1951), for instance, depicted play as a frivolous, carefree activity, situated outside of daily live. Salen & Zimmerman (2003) described play as a (care)free interaction depicted by informal rules, while Caillois (2001) defined play as an activity which was essentially, free, separate, uncertain, unproductive, governed by rules and make believe. The above were all descriptions of feelings, experiences and cultural connotations that were connected to games. It was not defined, however, in what way the specific activity of playing (and gameplay) differed from interactions with other media, such as books and movies.

Some academics do characterize the activity. For example, Copier (2007) characterizes play as a social negotiation. The word negotiation qualifies play as an interaction where goods or values are going back and forth between players, designers and the game itself. Copier differentiates games from books and movies by claiming that gaming always resolves around, or through, social interactions. This characterization of play as a social negotiation, shifts debates from experiences to process.

Developmental psychologists Jarvis, Brock & Brown (2008) characterize play as a process as well. They describe play as (cognitive) restructuring, suggesting the manipulation, rearrangement and changing of an existing configuration to create something anew. The word 'restructuring' in this case, describes what happens in players' mind.

This thesis moves onward from Jarvis, Brock & Brown and Copier's characterization of play by describing the activity that takes place outside players and in direct relation (or negotiation) with the players' environment. Players do not only restructure relations in their mind, they also alter or manipulate tangible or virtual objects outside the confines of their own head. This always occurs within a socio-cultural environment and it is within this social environment and through the act of restructuring that players change something – and as a result, create something new.

Defining play as a restructuring practice that emerges from the negotiations between actors within a socio-cultural network may contribute to academic debates about play, as it transcends cognitive and socio-cultural definitions by describing the activity of play itself.

From a designer's perspective it may proof valuable to approach games as a process, instead of focusing on the emotional experiences that resonate from the act of playing.. Regarding play as a restructuring practice may ease the integration of the learning with gameplay (see section 5 to 7), since designers can search for restructureable elements in the learning content, and translate them (almost) directly to gameplay.

Play as a restructuring practice contributes to both academic research and design practice. In academics it may transcend discussions on the (emotional) effect of play to describe the actual activity or process of play. In turn, the characterization of the process may help designers to integrate the element of learning with a game, since they do not have to focus on the ambiguous experiences resonating from play. Instead they can focus upon the playful quality of the learning content.

11.2 Practical guidelines

The second contribution of this thesis is a series of practical guidelines to autonomy-supportive game design. This section first discusses how the methods discussed contribute to existing methods in academics. It will position the Applied Game Design Model as a practical contribution to more general design tools in open-ended play and critical game design first. Secondly it is described how the guidelines can help designers to create autonomy-supportive learning games.
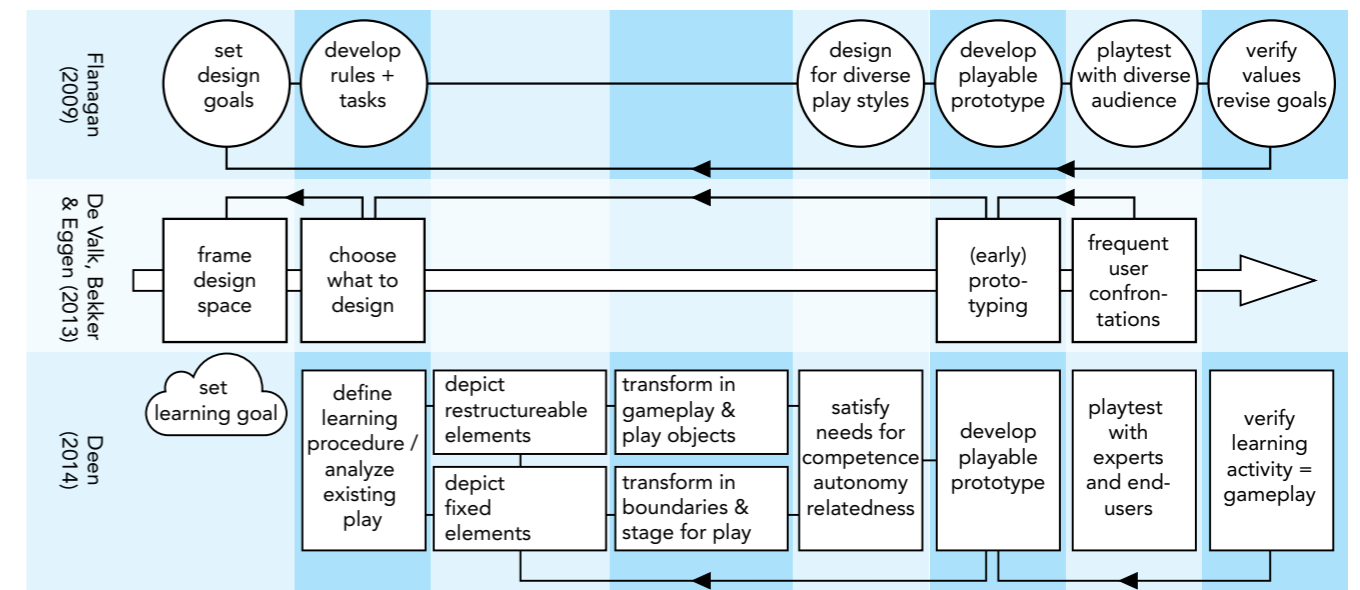
This thesis examines the application of games in the context of learning, focusing primarily on leveraging the motivational qualities of games to engage in learning. By zooming in on this small design space (games, learning, autonomy-support and motivation), it became clear that existing design guidelines were too generic, and therefore difficult to apply.

For example, Flanagan's (2009) model of critical play method puts high emphasis on play testing but gives little insights in the way designers can find the playful value of tough issues. The design model by De Valk, Bekker & Eggen (2013) for open-ended play emphasizes the value of short and direct iterations. Neither Flanagan, nor De Valk, Bekker & Eggen explain how designers can choose what to design.

The Applied Game Design Model that is introduced in this thesis contributes to above methods, explaining how designers can depict the playful value of a learning content and translate these into a game. The guidelines serve as a 'recipe' for autonomy-supportive games with educational purposes. It fills the blank spot of design practice that appears largely untapped by academics.

Designers can use the model as a guideline when choosing what to design. The model invites designers to narrow down a fuzzy (learning) concept to an explicit learning goal and study the implicit theory students have about the learning content, about the tone of instruction, and about the learning regulatory style. Consequently, the learning procedure can be defined and the restructureable and fixed elements of learning procedure are depicted.

Fixed elements are used to set the stage (the boundaries) of the game, whilst the restructureable elements can be transformed into playable objects. After the initial concept developmental phase, designers can decide how their game will utilize various regulatory types to satisfy needs for competence (e.g. [i + 1], progressive feedback), autonomy (e.g. offer many restructuring opportunities, present various solution to a challenge, design for various playing styles), and relatedness (e.g. parallel play, gameplay sharing, social interdependency).

mechanics   dynamics   aesthetics

AGDM

$3 \times 4 = .?.$

Epistemic Games   Autonomy-Supportive Games   Drill&Practice Games
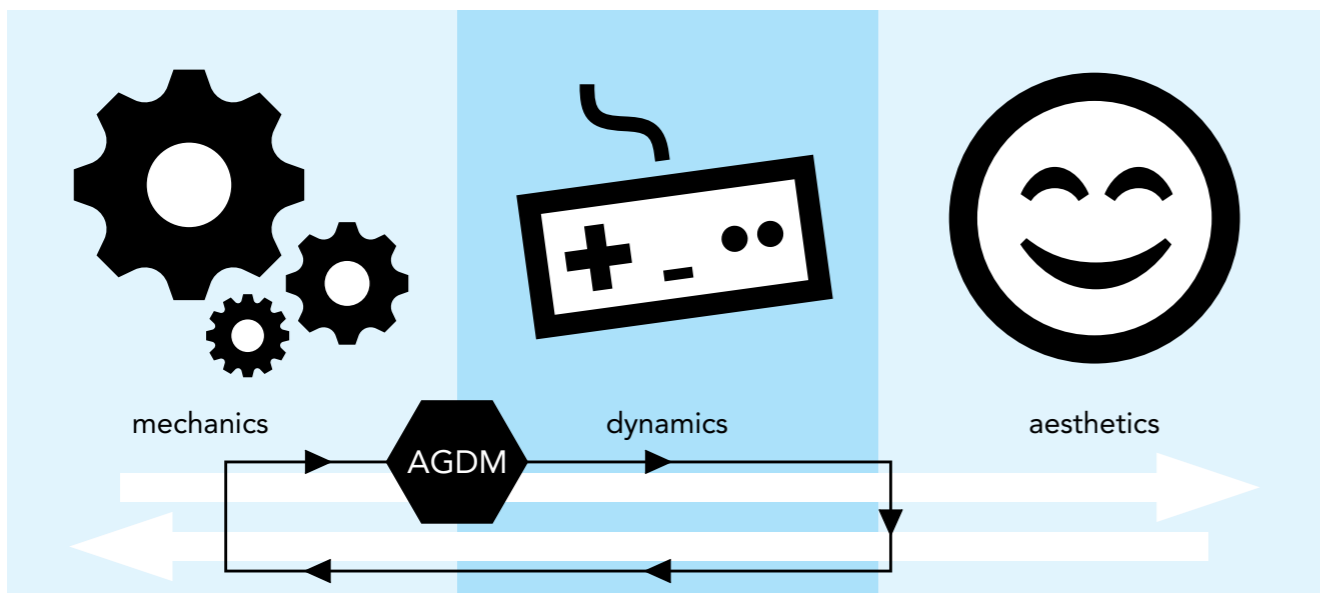
The Applied Game Design Model is one way to design autonomy-supportive learning games. It can be positioned as a practical implication of the MDA model (Hunicke, LeBlanc, & Zubek, 2004). Hunicke, Le Blanc & Zubek suggest that designers can develop games by starting with the mechanics (the rules and goals of the game) and the aesthetics (the intended emotional response). In comparison, the Applied Game Design Model is an attempt to describe a design process that originates from the dynamics (the playful activity). As such, it contributes a third way of designing to the MDA model.

However, it appears hard to design merely from the activity alone, since activities are often connected to objects, contexts and thoughts of players. It can therefore be argued that one cannot design from dynamics alone. This is especially true for educational games. For these games, the learning content prescribes a set of fixed rules and elements to be reckoned with. As a result the Applied Game Design Model is positioned as a design guideline that originates somewhere between the mechanics and dynamics (see Figure 126).

Nonetheless, the Applied Game Design Model suggests that starting with dynamics may proof valuable for autonomy-supportive design, since designers do not initiate their design practice from the confines of formal rules. Instead they can initiate their design form the relative freedom that is found in activities.

The design from dynamics approach differs from design approaches by Bogost (2007) and Fullerton, Swain & Hoffman (2004). Both the procedural rhetoric approach and play-centric design approaches appear to start with defining mechanics. According to Fullerton et al. 'Once you have decided on a concept you'd like to develop into a game, you should sit down and lay out the formal elements' (2004, p. 152) (e.g. the game mechanics). In educational game design, these formal elements are already there.

Instead of adding more regulations to the educational content the Applied Game Design Model asks designers to search for the restructureable elements within this content. The main question then becomes: what formal rules can be bend, changed, manipulated or rearranged without changing the core learning procedure? The Applied Game Design Model proposes designers to start with the activity and search for minimalistic tools to facilitate this kind of play. The focus on freedom in comparison to the focus on rules may ease the design of autonomy-supportive games, since freedom is such an important aspect of autonomous experiences.

The practical guidelines in this thesis bridge the gap in academic design methods between 'framing' and 'goal setting' on one side, to prototype development on the other side, by describing a more in-depth process on 'what to design' (see Figure 125). In relation to design practice, the guidelines may proof a valuable approach to create autonomy-supportive games. By starting with the richness of the activity instead of the limiting aspects of rules and regulations, it may be easier to create a sense of freedom.

In summary, the purpose of the Applied Game Design Model is to integrate learning into gameplay (Habgood, 2007) and unite the seriousness of thought with the experimental and emotional freedom of active play (Abt, 1971) in an attempt to leverage the motivational quality of games and engage players into learning. As such it contributes both to academic research and to design practice. It describes a yet unexplored part of academic design methodology, and it gives designers clear handles to work with.

11.3 Autonomy-supportive games

The last contribution of this thesis is the design direction that it formulates towards autonomy-supportive games. This section discusses how autonomy-supportive game design aligns with prior academic debates, followed by more practical contributions to game design. It appears that autonomy is the 'thread' that can connect three academic disciplines to one another: game (design) theory, developmental psychology and cognitive psychologists theories on human motivation.

First, game design (as depicted in this thesis) appears largely concerned with the design of restructuring practices. The more restructuring opportunities, the more autonomous players may feel. Since the amount of restructuring possibilities can be connected autonomous experiences, the design for autonomy-supportive games appears justified. Secondly, The thoughts put forward in this thesis about development psychology, especially social constructivists thoughts, try to abdicate responsibility of learning to students. As a result, these didactic approaches emphasize the value of autonomous learning experience in education. Thirdly, the cognitive psychologist view on human motivation called Self-Determination Theory, suggests that autonomy is one of the three universal human needs, that when satisfied may improve motivation. Autonomy-support connects the restructuring practices of games to the abdication of learning responsibilities in learning, with the focus of self-determination theory on satisfying needs for autonomy.

Within academic research, autonomy-supportive games for learning can be positioned in between Shaffer's (2008) epistemic games and what Aldrich (2009) called: Drill & Practice. Epistemic games are simulation like games that invite players to think from the perspective of a professional. By doing so, players learn why and how particular decisions may be made. In comparison, Drill & Practice are mostly digitized exercise that has players repetitively train particular skills. Autonomy-supportive games present players with opportunities to restructure various aspects of the learning content and help players to generate their own path towards a solution. Autonomy-supportive games create opportunities to explore and experiment, like epistemic games do, and focus on the construction of pre-defined knowledge, like Drill & Practice games. As a result, autonomy-supportive games take best of both worlds and can therefore be positioned in-between epistemic and Drill&Practice games.

11.4 Future research

This section discusses thoughts on future research. Based on the limitations of this thesis and on insights gained, three main future research directions are depicted. Firstly, what kind of games could transcend the quality and value of autonomy-supportive games, and how would these games be designed? Secondly, how can play as a process be characterized (other than a restructuring practice), how would this contribute to design practice and academic research in game theory? And thirdly, how could the Applied Game Design Model be used in other context than educations, and what kind of alterations are needed to make the model in an Autonomy-Supportive (Game) Design Model.

The first question: what kind of games could transcend autonomy-support? is mainly inspired by this thesis' focus on the design for autonomy-supportive games. The focus on games with strict boundary and rule sets in which players can generate their own path and find the solution for an answer, offers players the opportunity to explore, experiment and struggle with these rules and discover the 'truth' (behind the learning content) for themselves. As a result players learn and grow while playing. This form of self-actualization is one of the highest desires in Maslow's pyramid of human needs (1943).

The last need depicted by Maslow is that of self-transcendence, meaning the willingness to connect to something beyond the ego, or to help others in realizing their full potential. In this thesis it is explained how the desire for self-transcendence is eminent in MMORPGs like World of Warcraft (Blizzard Entertainment, 2004). However, these acts of supporting lower-level characters relate only to the game's context, rules and goals. According to McGonigal (2011) games could be used to make the world a better place. And according to DeKoven (2004, 2004) a game can be made out -of and for everything.

Would it be possible to develop games that are more than autonomy-supportive and focused on self-actualization? Would it be possible to find the restructureable elements in our daily lives and those of others? Transform them into gameplay and structure the game in such a way that it stimulates players to help each other? A study like this would not only transcend the value of play as restructuring to other domains, it might even make effect our lives in new an unpredictable ways. In other words, would it be possible to create games that have players connect to something beyond the ego and help other to realize their full potential? Or, how can self-transcending games be developed that connect to situations outside the game context?

The second question: how can play be characterized as a process other than being a restructuring practice? directly relates to this thesis' main design perspective, play is restructuring. New characterizations may be found in other academic disciplines or from closer collaboration with the game industry. Play as restructuring practice emerged mainly from design experiences with students and colleagues. From professional experiences at Ranj Serious Games, organizing several Games [4:...] Jams, facilitating workshops at conferences and from personal game design experiences. These personal experiences include the design of Combinatorics, an art-school graduation project GaymOver, the design and research to SwimGames, participating in Game Jams (a.o. Global Game Jam, Lyst Summit, Pillo Jam), and developing games for parent-child-interaction at Lapp. View studies were performed in direct cooperation with the field of serious games development.

Since the theoretical grounding of this perspective is anchored in academic disciplines, and the practical implications of theoretical perspectives were studied in and around the university, the suggested connections to the game industry may appear a little far-fetched Future research could study the applicability of the model in the design practice of professional studios, trying to answer the question: how could play be characterized, and how would this contribute to academic game theory and professional game development?

The last question: how could the Applied Game Design Model be used in other contexts? is largely derived from insights gained from the validation study to Combinatorics and observations and experiences during the swimgames course. First, the validation study about Combinatorics studied the motivational impact of one game that was designed in accordance to the model and which was studied over a very short time. Logically, longitudinal studies to multiple games would present researchers with more insights in the motivational impact of games and the value of the model. Additionally, the model works well with mathematical challenges, but has not been validated in the context of other learning contents (such as second language acquisition, economics, etc). Performing longitudinal studies and examining different subject matters is one way to broaden the scope of the model. Another way to expand the use of the Applied Game Design Model is by studying the guidelines in regard to non-educational contexts. The swimgames case, for example, suggests two new design tools (tools for self-expressive, and tools for social negotiations) to satisfy needs for autonomy. It would be interesting to see how other contexts, such as advertisement, ideology, or counseling would incite alterations or contributions to the model.

11.5 Summary

This section discussed the main contributions of this thesis in relation to prior research and future research directions. It suggests that the characterization of play as a restructuring practice may contribute to new debates in academic research that may transcend discussions about the emotional and cultural significance of play, towards a better understanding of the playful activity itself. Furthermore, the guidelines, and especially the Applied Game Design Model, serves as a contribution to academic methods, explaining one way to decide 'what to design' in relation to autonomy-supportive learning games.

The Applied Game Design Model contributes to existing models by analyzing the decision-making process in-depth, and may help serious game designers to integrate the learning into the gameplay. Lastly, the focus on autonomy-supportive games connects three academic disciplines with one another. It also contributes a new design paradigm to the design practice in which autonomy-supportive games utilize the value of freedom and exploration of epistemic games and the focus on skill mastery and correct performance of Drill&Practice games.

12

CONCLUSION
AUTONOMY-SUPPORTIVE LEARNING GAMES

SECTION 12 **CONCLUSION**

This thesis is largely inspired by earlier studies on the motivational impact and educational value of games. Cognitive psychologists already claimed that games could contain intrinsically motivating features. This means that players do not need any rewards or reinforcement to play. Players who are intrinsically motivated consider the gameplay satisfactory in itself. By suggesting which game features are intrinsically motivating, the psychologists partly explain why these games are motivating. A short history of the game industry may therefore enlighten the reasons for studying games and motivations to learn.

From its earliest days, the motivational prowess of video games attracted attention from educators and trainers. They witnessed how young children and adolescents spend large amounts of their free time in game arcades. Games like *PacMan* and *Space Invaders* were played with a level of engagement that made educators' mouths water. What if they could use games' motivational features and put them into learning? Would that be a way to improve students' motivation to learn?

A review of early 80s' edutainment games suggests that many developers utilized the motivational aspects of *challenge* and *fantasy* to improve students' motivation to engage in learning exercises. This study proposes a different approach by adhering to Self-Determination Theory and the concept of Regulatory Fit. As a result, it studies the design and impact of *autonomy-supportive games*. The impact of autonomy-supportive learning games has seldom been empirically studied. The study therefore contributes to current studies on the effect of gaming on motivations to learn.

The studies of Habgood are most relevant in regard to motivation, games, and learning. Habgood's studies concern the motivation to play and learn in the context of a game. Habgood proved false the assumption that fantasy elements (and/or mythical and folklore representations) affected players' motivation to play. Habgood suggested that motivation towards ingame-learning could be increased if the gameplay would equal the intended learning. This thesis builds forth on Habgood's by examining the impact of games on 'out-of-game' motivation. In other words, what happens to students' motivation when the game is turned off?

Additionally, this thesis differs from other studies since it qualifies motivation by experienced Regulatory Style. A Regulatory Style describes the way in which someone feels driven, reinforced, or moved to engage in a particular activity. For example, students may feel that they have to learn because it is expected of them. They must learn to gain praise or avoid punishment. This experience is called external regulation, the motivations to learn come from 'external forces' (i.e. teachers, parents and peers).

Positioned on the other side of the 'regulatory continuum' is the experience of intrinsic regulation. Intrinsic regulations concern the experience of being intrinsically motivated. Intrinsically motivated individuals do not need an external 'push' to engage in learning, because, to them, learning is satisfactory in itself. Autodidactic, or autotelic students can be considered prime examples of individuals who experience intrinsic regulations, and they are considered the best learners. By qualifying motivation by experienced Regulatory Style (in comparison to quantifying motivation as high or low), this study may offer more insightful design guidelines to elicit motivation.

Figure 129: The arcade hall in the movie Terminator 2

Furthermore, Habgood argues that motivation towards learning (in-game) can be improved if designers adhere to the Integrated Design Approach. In this approach, designers search for ways to integrate the learning content as an integral part of the gameplay. In other words, the playing is the learning. It remains unclear however, how the learning content can be integrated. Nor do the aforementioned psychologists explain how to design games that are autonomy-supportive. None of the above scholars present a model to integrate the learning with gameplay and make games autonomy-supportive. That is why this study is largely concerned with the development of the *Applied Game Design Model*.

The *Applied Game Design Model* stimulates the development of autonomy-supportive games. This focus on autonomy-support is dictated by literature from developmental psychology, cognitive psychologists' theories on human motivation, and trends in the game industry. All three domains suggest a transition from formal and compliant interaction towards a more *autonomous* experience. This section shortly revisits thoughts on autonomy-supportive environments for learning (developmental psychology), motivation (cognitive psychology) and games (design and humanities), to illustrate its value to autonomy-supportive games with educational purposes.

Development psychology
According to Vygotsky and Bandura, knowledge is something that is constructed by individuals in their own way and on their own pace. These social constructivists believe that knowledge is never constructed in vacuum, but comes into being through social negotiations between individuals. Students debate, discuss, and change the relations between knowledge actors. By restructuring socio-cultural knowledge networks, students construct new knowledge and new insights.

Bandura suggests that knowledge is not transferred from the teacher to the students. Instead learning is considered a process of knowledge *construction*. Individuals construct their own knowledge by exploring, experimenting and struggling with the learning content in order to find the 'truth' behind the learning for themselves. Again, they restructure existing relations between actors. They add and dismiss relations and actors to construct knowledge themselves.

Learning is a personal experience. The New Learning movement invites teachers to facilitate the learning instead of instructing and explaining the learning content. As a result, students, not the teachers, are responsible for their own progress. Teachers in social constructivist thought facilitate the learning. They create autonomy-supportive environments in which students can learn in accordance to their own learning style.

Human motivation
According to Ryan & Deci, motivation is high when the locus of causality is internal to individuals. This means that people experience a sense of mastery and control over their own performances. Motivation can be increased when individuals feel able to overcome certain obstacles successfully. In this way needs for competence are partly satisfied, which becomes a gratifying experience.

If students can learn with significant others, needs for relatedness are satisfied. Like competence, satisfying needs for relatedness is considered to be a universal human need by Self-Determination Theory. Schools are very well designed to satisfy needs for competence and relatedness. With the introduction of social constructivist learning methods in education, schools tend to satisfy needs for autonomy as well.

If teachers succeed in satisfying needs for *competence*, *autonomy* and *relatedness*, students may feel increasingly self-determined (e.g. autonomous). As the name suggests, Self-Determination Theory emphasizes the autonomous experience above all, when it comes to improving human motivation. Still, supporting autonomy is not without challenges. It is difficult to find the right balance between presenting students with enough freedom to feel autonomous, and facilitate the right boundaries to satisfy needs for competence.

Game design
Lastly, trends in the game industry suggest a growing interest amongst developers to facilitate autonomous play experiences. Players are increasingly able to generate their own paths to a solution. What's more, games that focus upon player-generated-content are gaining increased interest. Examples are modding communities that are backed by developers, and today's booming indie-game scene. Game designers and companies increasingly abdicate the authorship of gameplay and game mechanics to their players. Games are increasingly becoming autonomy-supportive environments, empowering players to create their own game.

Considering the above issues on autonomy-support in education, motivational theories and game design, two research questions emerged:

· How can autonomy-supportive games with educational purposes be designed?

· How can autonomy-supportive learning games improve students' motivation to learn?

In order to create autonomy-supportive games with educational purposes, designers could take the next four design steps into consideration:

1. **Translate the learning content into a procedure** (a set of actions and outcomes) and clearly describe its main learning goal.

2. **Find the restructureable and fixed elements** in the learning procedure: What can you change without changing the learning outcome?

3. **Translate the fixed elements to main mechanics** that facilitate the exploration, experimentation and struggle with restructureable (playful) elements.

4. Create ways to **satisfy needs** for:

   a. **Competence** (Zone of Proximal Development & Progressive Feedback).

   b. **Relatedness** (Parallel Play, Social Interdependency & Gameplay sharing).

   c. **Autonomy** (Playing Styles, Multiple Solutions & Regulatory Fit).

If a game creates a synergy between learning procedure and gameplay, and is able to satisfy needs for competence, autonomy and relatedness, the learning regulations may be internalized to the players' self. In turn, this may increase players' motivation to learn. We found no evidence that students' intrinsic motivation towards learning increased after playing an autonomy-supportive game.

Students did report they felt less enforced by their environment to engage in learning. This suggests that autonomy-supportive games can have a positive impact on students' motivation to learn, but that we cannot (yet) state that students actually internalized the learning regulations to their selves and became intrinsically motivated. It appears that more thorough and longitudinal studies are required to validate that hypothesis.

12.1 Challenges

The most challenging aspect of this study were:

1. To gain an understanding about the theory and practice of integrating the learning content with the gameplay.

2. To create a game that is autonomy-supportive but still educates students in the intended knowledge.

In order to confront this challenge, all three domains (learning, gaming and motivation) are considered to be a *restructuring practice*.

Restructuring concerns the manipulation, changing and rearranging of existing structures to construct something new. Restructuring is a quality that is inherent to gameplay. If players cannot restructure, players are not playing a game. Additionally, restructuring practices are discerned in learning and motivation as well. Approaching learning and gaming as a restructuring practice proved a valuable approach to develop a game that was about the learning and which elicited autonomous experiences.

12.2 The 3 stages of research

It was hypothesized that autonomy-supportive games might reduce externally regulated experiences towards education. This is a positive motivational change in regard to education. In order to validate this hypothesis the following study was conducted.

The study consisted of three stages. Stage one concerned a literature review. Desktop research was performed to gain insight into human motivation, game theory and developmental psychology. Stage two concerned a research through design approach. The game, *Combinatorics*, was developed to be used as a case study and research tool. The development of *Combinatorics* made stage three possible. Namely, the validation of the impact of an autonomy-supportive game on motivation to learn.

Stage 1: Literature review
Desktop research to motivation concerned a literature study in social psychology and cognitive psychology. Theories from social cognition and need theory that appeared most applicable to learning and gaming were found in the concepts of *Regulatory Fit* by Bianco, Higgins & Klem, and *Self-Determination Theory* by Ryan & Deci.

Regulatory Fit suggest that motivation is increased when the tone of instruction corresponds to the implicit theory students have about the learning. For example, if a history teacher witnesses the motivation of students dwindle, the teacher may assume that making the lessons more fun may boost motivation. The teacher fills the learning content with comical anecdotes and lightens the tone of instruction to a less serious one.

However, students can have an implicit theory about historical events being of importance. History can be considered to have weight, and not be a frivolous affair. As a result, 'funning up' the learning does not result in increased motivation. The regulatory misfit between tone of instruction and students' implicit theory may actually lower students' motivation considerably.

According to a theory in cognitive psychology called Self-Determination Theory, motivation can be enhanced when three universal human needs are satisfied in the context of the learning activity. If the needs for competence, relatedness and autonomy are satisfied, students may internalize the learning regulations to their selves. This means that students brought the rules, goals, and ways to act in congruence with their personal selves. When these needs are satisfied, students can identify with the learning content as something that they feel is of intrinsic value to them. In turn, this may increase motivations to learn.

Needs for competence can be satisfied through careful scaffolding of both the learning content as gameplay. The rule: [i + 1] appears a means to raise the difficulty level of a game step by step. What's more, the design of Progressive Feedback, presenting players with what was accomplished and what is to come, presented another opportunity to satisfy needs for competence.

Needs for relatedness can be satisfied in various degrees. From moderate to intense social negotiations, this study differentiated parallel play (moderate), sharing practices (intermediate), and the design of interdependency amongst players (intense) as ways to satisfy needs for relatedness.

Needs for autonomy can be satisfied in a multitude of ways. The design for autonomy-support is the main premise of this thesis. Schools are already very well equipped to satisfy needs for competence and relatedness. However the ambiguity that characterizes autonomy-support appears more difficult to implement. Games appear ideal media to satisfy needs for autonomy. In section 8.2 a taxonomy of various degrees of autonomy-support are discussed. The degree of autonomy-support appears to correlate with the amount of restructuring possibilities. In other words, the more players can play, the more autonomous they may feel. Additionally, needs for autonomy can be satisfied by *facilitating*:

1. Possibilities to **explore**, **experiment**, and **struggle** with the learning content to find the truth behind the learning for oneself.

2. Possibilities to **generate one's own path** to a solution.

3. Possibilities to play in accordance with one's preferred **approaching style.** This thesis distinguished a *theoretical*, *pragmatic*, *interpersonal* and *self-expressive style* of play/learning.

Furthermore, desktop research on self-determination brought forth a way to qualify motivation by subjects' experienced Regulatory Style. Students can feel *externally-*, *introjected-*, *identified-*, *integrated-* and *intrinsically* regulated to perform in learning activities (see section 8.2. It is suggested that in education the design from identified regulations may be the most feasible approach to improve motivation. External regulations can be used to set the stage and quickly instruct/explain the ramifications of the game. Introjected regulations should be avoided as much as possible to avoid failure anxiety amongst students.

Education

The study on education concerned a literature study of developmental psychology. With its long history, ranging back to the 19th century, developmental psychology brings forth a multitude of insights and perspectives. This thesis suggests that social constructivism appears to be a good marriage when it comes to a didactic approach for serious games.

Social constructivists suggest that knowledge cannot be transferred from teacher to students. Instead, students are considered to construct knowledge themselves. This presents them with the responsibility for their own progress, and students are treated as autonomous individuals. Teachers transform from content deliverers into coaches. A coach encourages learning and presents students with new challenges just a little beyond the students' existing cognitive levels.

Two concepts from developmental psychology inspired many decisions in developing the *Applied Game Design Model*. These are: 1) Scaffolding, or the *Zone of Proximal Development*, and 2) *Self-efficacy*. Scaffolding suggests breaking down the learning content into manageable pieces. Self-efficacy concerns the belief that particular challenges can be overcome successfully. Both concepts focus upon competency development in autonomy-supportive environments.

Game Design

A theoretical analysis of game theory brought forth the vision that play is by definition a *restructuring process through social negotiations of human an inhuman actors in a socio-cultural network*. This definition came about by studying the growing amount of literature concerning two decades of academic studies on games. Game theory is a multidisciplinary field of studies. As a result, the above definition was highly influenced by thoughts in Humanities, Developmental Psychology and Human Computer Interaction.

Humanity influences are found in adaptation of the works of Copier. Copier urged for incorporating social negotiations between players, designers, the game and the cultural discourse connected the three as invaluable approach to understand the cultural impact of games. The term negotiation is used to underline that the interactions between actors can be qualified by value and strength. Playing is always a 'trade-in' of a commodity in order to receive something in return. It transcends mere interaction, as negotiations can be monetized in terms of energy, status and actual money.

Developmental psychology influences are brought in by the works of Brock, Dodds, Jarvis & Olusoga. Brock et al. inspired the term restructuring. Being developmental psychologists, the way Brock et al. debate 'restructuring' mainly concerns cognitive negotiations. This thesis suggests that the restructuring actually involves the aspects *outside* the human mind. The changing, rearranging or manipulating of an actual artifact (e.g. the game) to create something new is what differentiates games from media like movies and books. It is therefore that this thesis brings restructuring to the foreground as play's main characteristic.

This play is considered to be an autonomous experience. This suggestion is strengthened by work done in human computer interaction called Open Ended play. Open Ended play suggest that players are given a minimal set of rules or interaction and can negotiate how to play the game. Again, players of Open Ended games are empowered to create their own game.

The literature study in all three domains brought forth the vision that learning and gaming should entail an autonomous experience in order to:

1. **Resonate the intrinsic qualities of gaming**: being an autonomy-supportive restructuring practice.

2. **Conform to modern thoughts on education**: offering students the opportunity to explore, experiment and struggle with the learning content to find the truth behind the learning for themselves.

3. **Improve motivation** by presenting individuals with the power to self-determine their own paths towards a particular solution, and therefore satisfying needs for autonomy.

Stage 2: Research Through Design

The second stage of the study involves a method called *Research Through Design*. This helped to validate various hypotheses that emerged from literature review and to gain greater insight in the design process of an applied game. This way the study contributed to the works of Habgood, and earlier Abt. They mainly described *what* an applied game should be like.

Habgood suggested the need for an Integrated Design Approach to make the learning an integral part of the gameplay and to raise motivations to learn/play. However, the scholars did not explain *how* the design process worked. This thesis brings forth the *Applied Game Design Model*. The model illustrates the 'how' of designing autonomy-supportive games that integrate the learning as integral part of the gameplay.

Key to the *Applied Game Design Model* is understanding that gaming and learning can be characterized as a restructuring process. It became clear, that some educational elements cannot be restructured (changed, manipulated or rearranged) without changing the learning content itself. These non-restructureable elements are dubbed 'fixed elements'. Fixed elements can set the stage for playful activities with the elements that *are* restructureable. They correspond well with external regulations, explaining what can and what cannot be done in the game in a rather rigid manner.

The development process of *Combinatorics* (and 80+ games with students of Fontys School of ICT) offered insights into design decisions for autonomy-supportive gameplay, as well as ways to satisfy needs for competence. For example, one aspect of autonomy-support is that individuals can generate their own path to a solution. For *Combinatorics*, this could literally be translated to the design of multiple routes to one answer. Surprisingly, playing styles appear to emerge naturally from facilitating restructuring practices (e.g. play).

The autonomous experience of playing with the restructureable elements elicited all kinds of negotiations. Most interestingly, players appeared to perform in a Trial & Error way of learning. Players fumbled around. Although they told researchers that they did not really understand what they were doing, players intuitively made the right decisions to overcome the game's challenges. This learning style is less possible in the course-book. As such, the game could enrich current learning practices with a learning method that changed the negotiations with learning content.

The above observation mainly concerns player experiences. However, the Research Through Design method revealed some design issues as well. It appeared that level-design could easily digress game designers from the learning content. Some levels of *Combinatorics* appeared too difficult. These levels shifted players' focus upon untangling the roadmap instead of the mathematic challenge. Consulting domain experts in various stages of development appears to be a necessity to adhere to the Integrated Design Approach.

Additionally, Bogost's Procedural Rhetoric proved to be a valuable contribution to the design process. Defining the learning as a procedure appears to be a useful step in abstracting the learning content to a workable level. Defining the learning procedure eased the formulation of the restructureable and fixed elements of the learning content. As such, the game's mechanics and dynamics emerged almost naturally from this step in abstraction.

Furthermore, the research through design method revealed how Regulatory Fit concerned the development of mood boards and play personas. Normally mood boards and persona development concern the interests and activities of the target audience. These can be considered rather broad, and therefore difficult to design for. For example, a mood board of children aged seven to eight can contain references to both Pokémon and Barbie. The aesthetics of Pokémon and Barbie differ significantly, making it difficult to correspond to the interests and activities of the target audience as a whole.

The concept of Regulatory Fit eases design by narrowing design freedom to the targeted audience's implicit theory about the subject matter at hand. Designers do not have to develop for all different interests of their targeted audiences. Instead they can connect to players' expectancies about the subject matter. The implicit theory of students appear more homogenous, and therefore easier to design for.

Stage 3: validation
The third stage concerned an empirical study. In this study 105 students of secondary education, aged 15 to 16, played either the autonomy-supportive mode of *Combinatorics* or a Drill & Practice mode. Players of the autonomy-supportive mode could generate their own paths to a solution, whilst players of the Drill & Practice mode could only give one right answer. Players completed a pre- and a post-game survey. The survey consisted of 32 statements taken from the Academic Self-Determination Questionnaire by Ryan & Connel.

On a four point Likert scale, subjects indicated their reasons for pursuing mathematics learning activities. For example, students where asked for the reasons to do classwork. They could rate statements such as 'So that the teacher won't yell at me' or 'Because, I want the teacher to think I'm a good student'. The yelling teacher statement suggests that students perform to avoid punishment. This corresponds to *external regulations*.

The second statement, 'being a good student', suggests a sense of worth and self-esteem. Feeling 'of worth' in comparison to performing in a learning activity corresponds to introjected regulations. The latter may lead to failure anxiety, whilst external regulations may have students disown responsibility for progress to others (e.g. the teacher).

The time between pre- and post-game tests was deliberately short (30 minutes) to decrease dropouts and minimize external influences. What's more, the in-game comparison study focused upon design decisions. This circumvented some issues that are related to media comparison studies (i.e. comparing game interventions with course-book exercises). For one, reports from control group (course-book exercise makers) would not be influenced by control-group jealousy towards the game players. Nor could novelty of using games in the classroom depict students' reports.

12.3 Contributions

Main contributions of the thesis concern game design studies. The literature study and research through design process brought forth the Applied Game Design Model. The model consists of two parts. The first part describes a method to connect learning with gaming. The premise of the model is to integrate the learning as integral part of the gameplay and to create an autonomous learning experience.

The Applied Game Design Model can ease the development of games that have students *play* with the learning content. Key in utilizing the model is approaching playing and learning as a restructuring practice. Defining the fixed and restructureable elements of a learning procedure directly translates to the design of mechanics and dynamics.

The additional guidelines incorporate motivational features distilled from self-determination and Regulatory Fit. It suggests design that corresponds to identified regulations. Hence, the design encourages the identification of the player with the gameplay (e.g. the learning procedure embedded in the game) by adding:

1. Ways to **satisfy needs for competence**:

   Zone of Proximal Development.

   Progressive Feedback.

2. Ways to **satisfy needs for autonomy**:

   Facilitating restructuring practices.

   Various paths to one solution.

   Various approaching styles.

   Experimentation, exploration and struggle with the learning procedure (to have students find the truth behind the learning for themselves).

3. Ways to **satisfy needs for relatedness**:

   Parallel play.

   Sharing Gameplay .

   (Social) Interdependency.
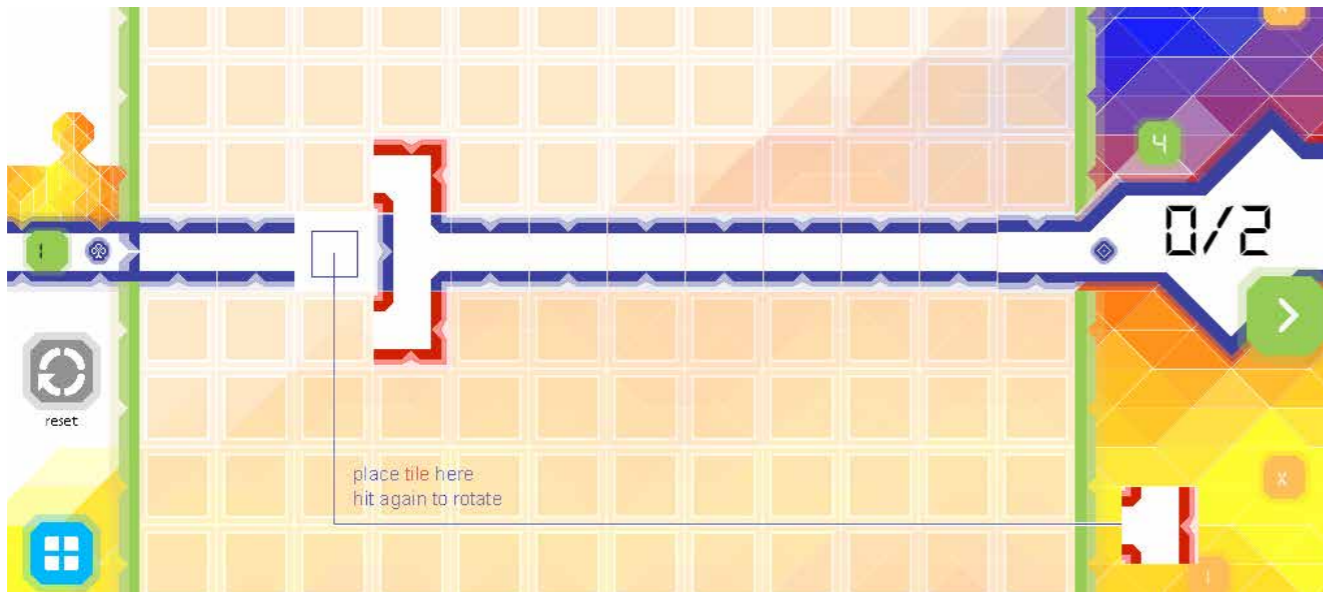
The model is validated by results from a study of the math game *Combinatorics*. Results suggest a mood-change for both modes. Autonomy-supportive mode players remained externally regulated to learn mathematics after the play session. They appeared to change their answers from 'very true' towards 'true'. In comparison, Drill & Practice players reported a mood-change from 'very untrue' towards 'untrue' for statements that suggested intrinsically regulated learning.

The time period between pre- and post-game tests was intentionally short to limit dropouts and external influences. This may account for the small differences in mean scores. Still, the mean differences were significant, and suggests that the game can improve motivation towards mathematics education.

Furthermore, the concept of Regulatory Fit may elicit a shift in design practice. Mood boards and play personas typically describe content-unrelated interests of the targeted audience. Regulatory Fit asks designers to study the implicit theory of students about the learning content. As a result, designers do not design for their targeted audience interests, but for a connection between students' expectancies about the instruction and the actual tone of instruction.

The mean differences found in the empirical study suggest a positive mood-change in experienced regulation. Motivation towards learning appears to be influenced by both modes. The changes found are significant for different types of regulations. This raises questions about the actual change in motivation that may be elicited by the game. Future research could study the impact of various autonomy-supportive games over a longer period of time. Thus, a longitudinal comparison study is proposed.

This thesis presented researchers and developers with a design method to design autonomy-supportive games that fit the curriculum. This may ease the development of more games to perform a longitudinal study to the impact of autonomy-supportive games on students' motivation to engage into learning (outside the game context). However, it remains unclear whether or not the model works for other contexts as well. We already explored the model in the context of school-classrooms, swimming centres and public space. These explorations refined the model in various ways. That is why designers are invited to work with the model and share their findings.

12.4 Final conclusion

Games can have strong motivational power to engage students in learning. However, the game elements that account for engagement and its effect on motivations to learn (out-of-game) are seldomlly studied empirically.

This thesis provides a theoretical and empirical explanation of game designs that satisfy needs for autonomy. Theoretically it brings forth the *Applied Game Design Model* as manner to integrate the learning content with the game mechanics. Key to applying the model is approaching learning and gaming as a *restructuring practice*. Designers can search for the restructureable elements in the learning procedure and consequently transform these into playful mechanics.

A validation study compared the reported change in experienced Regulatory Style amongst adolescents. Two groups of students played an autonomy-supportive mode or a compliant mode of *Combinatorics*. Findings suggest that the restructuring practices found in the autonomy-supportive mode may lower the feelings amongst students that they *must* learn for reasons outside their own personal interest. Additionally it is suggested that the mode stimulates Trial & Error learning and fosters the development of intuitive knowledge.

It is concluded that autonomy-supportive games may lower the barriers for social constructivist forms of learning, as they emphasize students' autonomy and personal responsibility for knowledge construction. Students' motivation towards learning can be improved by facilitating restructuring practices with the learning procedure. This can be accomplished through the design of autonomy-supportive games.

As a designer-researcher I am looking forward to applying and refining the Applied Game Design Model in new contexts. How would the search for restructureable elements work on ice-skating, sailing, equal human rights, or even mental health?

Let's find out together ☺

REFERENCES

Aben, J., Arnett, B., Boles, D., & McDonalds, B. (2014). *A Beautiful Sunday*. PC: Games [4...] Jam. Retrieved from http://www.gamesjam.nl/project/beautifulsunday/

Abt, C. C. (1971). *Serious Games*. New York: Viking Compass.

Aldrich, C. (2009). *The Complete Guide to Simulations and Serious Games: How the Most Valuable Content Will be Created in the Age Beyond Gutenberg to Google*. John Wiley & Sons.

Bandura, A. (1997). *Self-Efficacy in Changing Societies*. Cambridge University Press.

Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD research*, *1*(1).

Bateman, C. (2008). Only a Game: A Game Isn't a Series of Interesting Decisions. *OnlyAGame*.

Berger, P. L., & Luckmann, T. (1991). *The social construction of reality: A treatise in the sociology of knowledge*. Penguin Books.

Berlyne, D. E. (1960). *Conflict, arousal, and curiosity*. McGraw-Hill.

Bianco, A. T., Higgins, E. T., & Klem, A. (2003). How "Fun/Importance" Fit Affects Performance: Relating Implicit Theories to Instructions. *Personality and Social Psychology Bulletin*, *29*(9), 1091–1103.

Björk, S., & Holopainen, J. (2004). *Patterns in Game Design*. Charles River Media.

Bogost, I. (2007). *Persuasive Games: The Expressive Power of Videogames*. The MIT Press.

Bogost, I. (2008). The rhetoric of video games. *The ecology of games: Connecting youth, games, and learning*, 117–140.

Bordewijk, J. (Ed.). (2009). *Bachelor of ICT, domeinbeschrijving*. Amsterdam: HBO-I stichting.

Brathwaite, B. (2010). *Train (or How I Dumped Electricity and Learned to Love Design)*. Presented at the GDC 2010, San Francisco. Retrieved from http://www.gdcvault.com/play/1012259/Train_(or_How_I_Dumped_Electricity_and_Learned_to_Love_Design)

Brock, A., Dodds, S., Jarvis, D. P., & Olusoga, Y. (2008). *Perspectives on Play: Learning for Life*. Longman.

Bruckman, A. (1999). Can Educational Be Fun. Presented at the Game Developers Conference 99, San Jose, CA.

Cai, J. (2007). What is effective mathematics teaching? A study of teachers from Australia, Mainland China, Hong Kong SAR, and the United States. *ZDM*, *39*(4), 265–270.

Caillois, R. (2001). *Man, Play and Games* (Reprint.). University of Illinois Press.

Canossa, A. (2005). Designing Levels for Enhanced Player Experience Cognitive tools for gameworld designers. IO Interactive / Denmark's School of Design.

Canossa, A. (2007). Weaving Experiences Values Modes Styels and Personas. IO Interactive / Denmark's School of Design.

Canossa, A. (2008). Towards a theory of Player: Designing for Experience. IO Interactive / Denmark's School of Design.

Canossa, A., & Drachen, A. (2009a). *Play-Personas: Behaviours and Belief systems in User-Centred Game Design*. IT University of Copenhagen.

Canossa, A., & Drachen, A. (2009b). Patterns of Play: Play-Personas in User-Centred Game Development. In *DiGRA 2009*. Presented at the Breakin New Ground: Innovation in Games, Play, Practice and Theory, London: DiGRA.

Castells, M. (2002). *The Internet Galaxy: Reflections on the Internet, Business, and Society*. OUP Oxford.

Chen, J. (2007). Flow in Games (and Everything else). *Commun. ACM*, *50*(4), 31–34.

Christel, M. G., Stevens, S. M., Maher, B. S., Brice, S., Champer, M., Jayapalan, L., … Lomas, D. (2012). RumbleBlocks: Teaching science concepts to young children through a Unity game. In *2012 17th International Conference on Computer Games (CGAMES)* (pp. 162–166). Presented at the 2012 17th International Conference on Computer Games.

Clark, R. E. (2001). *Learning from Media: Arguments, Analysis, and Evidence*. Information Age Publishing.

Cluitmans, J., Bloemen, P. P. ., Oeffelt, T. van, & Dekkers, M. A. F. (2009). *Aan de slag met competenties: een kennisbasis over competentiegericht leren voor de onderwijsprofessional*. Nuenen: Onderwijsadviesbureau drs. M.A.F. Dekkers.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning styles and pedagogy in post-16 learning: A systematic and critical review*. London: Learning and Skills Research Ce ntre. Retrieved from www.LSRC.ac.uk

Consalvo, M. (2009). *Cheating: Gaining Advantage in Videogames*. The MIT Press.

Cooper, A. (2004). *The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity* (1st ed.). Sams - Pearson Education.

Copier, M. (2005). Connecting Worlds. Fantasy Role-Playing Games, Ritual Acts and the Magic Circle. *Proceedings DiGRA 2005 Conference: Changing Views - Worlds in Play*, 16–20.

Copier, M. (2007). *Beyond the magic circle : A network perspective on role-play in online games*. Utrecht University, Utrecht.

Csikszentmihalyi, M. (2002). *Flow: The Classic Work on How to Achieve Happiness* (New edition.). Rider & Co.

Dance, Voldo, Dance. (2010). Retrieved from http://www.youtube.com/watch?v=k08gjJbxG-A&feature=youtube_gdata_player

De Telegraaf. (2013, August 21). iPad-scholen van start. *Telegraaf.nl*. Retrieved October 17, 2013, from http://www.telegraaf.nl/feed/21823927/__iPad-scholen_van_start__.html

DeCharms, R. (1968). *Personal causation: The internal affective determinants of behavior*. New York: Academic Press.

Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. R. (1994). Facilitating Internalization: The Self-Determination Thoery Perspective. *Journal of Personality*, *61*(1).

Deen, M. (2009). *Onderzoeksrapport validatie CheckOut!* Ranj Serious Games & ROC West-Brabant.

Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven: Leuven University.

Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches*. IGI Global.

Deen, M., Schouten, B., & Bekker, M. M. (Tilde). (2011). Playful Identity. In J. Reasens (Ed.), . Utrecht: Utrecht University.

DeKoven, B. (2004). *Junkyard Sports* (1st ed.). Human Kinetics.

DeMarco, M., Lesser, E., & O'Driscoll, T. (2007). *Leadership in a distributed world*. IBM Corporation.

DeMaria, R., & Wilson, J. L. (2003). *High Score!: The Illustrated History of Electronic Games, Second Edition* (2nd ed.). McGraw-Hill Osborne Media.

Derksen, J. (2013, August 29). "Steve Jobsschool? Ze leren het ook nooit in het onderwijs." *Volkskrant.nl*. Retrieved October 17, 2013, from http://www.volkskrant.nl/vk/nl/3184/opinie/article/detail/3500123/2013/08/29/Steve-Jobsschool-Ze-leren-het-ook-nooit-in-het-onderwijs.dhtml

De Valk, L., Bekker, T., & Eggen, B. (2013). Leaving room for improvisation: towards a design approach for open-ended play. In *Proceedings of the 12th International Conference on Interaction Design and Children* (pp. 92–101). ACM.

Dewey, J. (1910). *How We Think*. D.C. Heath & Co.

Dewey, J. (1997). *Experience And Education*. Free Press.

Dickey, M. D. (2005). Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. *Educational Technology Research and Development*, *53*(2), 67–83.

Dormans, J. (2009). *Machinations: Game Feedback Diagrams*. Retrieved from http://www.jorisdormans.nl/machinations/

Dormans, J. (2012). *Engineering Emergence: Applied Theory for Game Design*. University of Amsterdam, Amsterdam.

Dunn, R., & Griggs, S. A. (1995). A meta-analytic validation of the Dunn and Dunn model of learning-style preferences. Journal of Educational Research, 88(6), 353.

Egenfeldt-Nielsen, S. (2005). *Beyond Edutainment: Exploring the Educational Potential of Computer Games*.

Elkind, D. (2007). *The power of play: learning what comes naturally*. Cambridge, Mass.; London: Da Capo Lifelong ; Perseus Running.

Ertmer, P., Stepich, D., Flanagan, S., Kocaman, A., Reiner, C., Reyes, L., … Ushigusa, S. (2008). Instructional design model for well-structured and ill-structured problem-solving learning outcomes. AERA.

Eseryel, D. (2006). Expert conceptualizations of the domain of instructional design: An investigative study on the deep assessment methodology for complex problem-solving outcomes. Syracuse University.

Felder, R. M., & Spurlin, J. (2005). Applications, reliability and validity of the Index of Learning Styles. *International Journal of Engineering Education*, *21*(1), 103–112.

Felicia, P. (Ed.). (2011). *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches*. IGI Global.

Ferriss, A. L. (2010). Intellectual Autonomy. *Approaches to Improving the Quality of Life*, 43–50.

Flanagan, M. (2009). *Critical Play: Radical Game Design*. The MIT Press.

Fleming, N., & Baume, D. (2006). Learning Styles Again: VARKing up the right tree! Educational Developments, 7(4), 4.

Fleming, N. D. (1995). I'm different; not dumb. Modes of presentation (VARK) in the tertiary classroom. In Research and Development in Higher Education, Proceedings of the 1995 Annual Conference of the Higher Education and Research Development Society of Australasia, HERDSA (Vol. 18, pp. 308–313).

Flurry, J. (2011). *Parallel playing?* Retrieved from http://www.johnflurry.com/theblog/2011/02/03/parallel-playing/

Ford, M. E. (1992). *Motivating Humans: Goals, Emotions, and Personal Agency Beliefs*. SAGE.

Franceschini, S., Gori, S., Ruffino, M., Viola, S., Molteni, M., & Facoetti, A. (2013). Action Video Games Make Dyslexic Children Read Better. *Current Biology*.

Frasca, G. (1999). Ludology Meets Narratology: Similitude and differences between (video)games and narrative. *Parnasso*, *3*.

Frasca, G. (2001). *Videogames of the oppressed: Videogames as a means for critical thinking and debate*. Georgia Institute of Technology.

Frasca, G. (2003). Simulation versus Narrative: Introduction to Ludology. In M. J. P. Wolf & B. Perron (Eds.), *Video/Game/Theory*.

Freire, P. (2000). *Pedagogy of the oppressed*. Continuum International Publishing Group.

Fullerton, T., Swain, C., & Hoffman, S. (2004). *Game Design Workshop: Designing, Prototyping, & Playtesting Games*. CRC Press.

Game Trailers. (2013). Pokemon X & Pokemon Y Review. *GameTrailers.com*. Retrieved November 7, 2013, from http://www.gametrailers.com/reviews/scucit/pokemon-x---pokemon-y-review

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, Motivation, and Learning: A Research and Practice Model. *Simulation & Gaming*, *33*(4), 441–467.

Gee, J. (2003). *What Video Games Have to Teach Us About Learning and Literacy* (1st ed.). Palgrave Macmillan.

Gee, J. (2005). Learning by design: Good video games as learning machines. *E-learning*, *2*(1), 5–16.

Gee, J. (2008). Video Games and Embodiment. *Games and Culture*, *3*(3-4), 253–263.

Glas, M. A. J. (2010, October 15). *Games of Stake: Control, Agency and Ownership in World of Warcraft*. UVA, Amsterdam.

Goffman, E. (1959). *The Presentation of Self in Everyday Life* (1st ed.). Anchor.

Green, C. S., Pouget, A., & Bavelier, D. (2010). Improved Probabilistic Inference as a General Learning Mechanism with Action Video Games. *Current Biology*, *20*(17), 1573–1579.

Guthrie, J. T., & Alao, S. (1997). Engagement in reading for young adolescents. *Journal of Adolescent & Adult Literacy*, *40*(6), 438.

Habgood, M. P. J. (2007). *The effective integration of digital games and learning content*. University of Nottingham, Nottingham, UK.

Habgood, M. P. J., Ainsworth, S. E., & Benford, S. (2005). Intrinsic Fantasy: Motivation and Affect in Educational Games Made by Children. *Simul. Gaming*, *36*(4), 483–498.

Hallinger, P., & Bridges, E. M. (2007). A Problem-based Approach for Management Education: Preparing Managers for Action. Springer Science & Business Media.

Harpstead, E., MacLellan, C. J., Aleven, V., & Myers, B. A. (2014). Using extracted features to inform alignment-driven design ideas in an educational game (pp. 3329–3338). ACM Press.

Harpstead, E., Myers, B. A., & Aleven, V. (2013). In Search of Learning: Facilitating Data Analysis in Educational Games. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 79–88). New York, NY, USA: ACM.

Hecker, C. (2010). *Achievements Considered Harmful?* Presented at the GDC2010, San Francisco. Retrieved from www.gdcvault.com

Heckhausen, H. (1967). *The anatomy of achievement motivation*. Academic Press.

Helgason, D., Francis, N., & Ante, J. (2004). *Unity*. Unity Technologies.

Higgins, E. T. (2000). Making a Good Decision-Value From Fit. *Journal of Personality and Social Psychology*, *62*, 676–687.

High Voltage Software. (1998). *Lego Racers*. Nintendo 64: Lego Media.

Huitt, W. (2001). Motivation to learn: An overview. In *Educational Psychology Interactive: Motivation*. Valdosta, GA: Valdosta State University.

Huizinga, J. (1951). *Homo Ludens: Proeve Eener Bepaling van het Spel-Element der Cultuur*. Haarlem: H.D. Tjeenk Willink & Zoon N.V.

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A Formal Approach to Game Design and Game Research.

III, R. R. (2010). *Game Design: Theory and Practice, Second Edition*. Jones & Bartlett Publishers.

Janssen, C. (n.d.). What is Sandbox? *TechoPedia*. Retrieved April 15, 2013, from http://www.techopedia.com/definition/3952/sandbox

Jarvis, P., Brock, A., & Brown, F. (2008). Three Perspectives on Play. In *Perspectives on Play: Learning for Life* (pp. 9–39). Longman.

Jennings, F. G. (1967). Jean Piaget: Notes on Learning. *Saturday Review*, *20*, 81–83.

Justin.tv. (2011). Twitch.tv. *Twitch*. Retrieved from www.twitch.tv

Juul, J. (2005). *Half-Real: Video Games between Real Rules and Fictional Worlds*. The MIT Press.

Katz, N. (1990). Problem solving and time: Functions of learning style and teaching methods. *Occupational Therapy Journal of Research*, 10(4), 221–236.

Katz, I., & Assor, A. (2006). When Choice Motivates and When It Does Not. *Educational Psychology Review*, *19*(4), 429–442.

Ke, F., & Grabowski, B. (2007). Gameplaying for maths learning: cooperative or not? *British Journal of Educational Technology*, 38(2), 249–259.

Kennisnet. (2013). *Vier in balans monitor 2013*. Kennisnet.

Kent, S. L. (2001). *The Ultimate History of Video Games: From Pong to Pokemon--The Story Behind the Craze That Touched Our Lives and Changed the World* (1st ed.). Three Rivers Press.

Klabbers, J. (2006). *The Magic Circle: Principles of Gaming & Simulation: Third and Revised Edition*. Sense Publishers.

Klastrup, L. (2003). A poetics of virtual worlds. *Digital Arts and Culture*.

Koefnoen - Steve Job school. (2013). Retrieved from http://www.youtube.com/watch?v=za3c6wygkvk&feature=youtube_gdata_player

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2001). Experiential learning theory: Previous research and new directions. *Perspectives on thinking, learning, and cognitive styles*, 227–247.

Koster, R. (2010). *Theory of Fun for Game Design* (1st ed.). Paraglyph Press.

Korhonen, H., Montola, M., & Arrasvuori, J. (2009). Understanding playful user experience through digital games. *International Conference on Designing Pleasurable Products and Interfaces* (pp. 274–285).

Latour, B. (2007). *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford; New York: Oxford University Press.

Le, M., & Cliffe, J. (1999). *Half-Life: Counter-Strike*. PC: Vivendi Universal.

Lepper, M. R., Corpus, J. H., & Iyengar, S. S. (2005). Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates. *Journal of Educational Psychology*, *97*(2), 184–196.

Lepper, M. R., & Greene, D. (1973). Undermining Children's Intrinisc Interest with Extrinsic Reward: A Test of the "Overjustification" hypothesis. *Journal ol Personality and Social Psychology*, *28*(1), 129–37.

Levinson, M. (2004). Is Autonomy Imposing Education Too Demanding? A Response to Dr. De Ruyter. *Studies in Philosophy & Education*, *23*(2/3), 223–233. doi:Article

Librande, S. (2009). *Paper Prototypes of Spore*. Presented at the GDC 2009, San Francisco. Retrieved from http://www.joystiq.com/screenshots/ea-maxis-paper-games/1457540/

Loh, C. S. (2012). Information Trails: In-Process Assessment of Game-Based Learning. In *Assessment in Game-Based Learning*. Springer New York.

Lucero, A., & Arrasvuori, J. (2010). PLEX Cards: a source of inspiration when designing for playfulness. In *Proceedings of the 3rd International Conference on Fun and Games* (pp. 28–37).

Lucero Vera, A. A. (2009). Co-Designing Interactive Spaces for and with Designers: Supporting Mood-Board Making. Eindhoven University of Technology, Eindhoven.

M.D, S. B., & Vaughan, C. (2009). *Play: How it Shapes the Brain, Opens the Imagination, and Invigorates the Soul* (1st ed.). Avery.

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, *5*(4), 333–369.

Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review*, (50), 370–396.

McGonigal, J. (2011). *Reality Is Broken: Why Games Make Us Better and How They Can Change the World* (400th ed.). Penguin Books.

Meadows, M. S. (2002). *Pause & Effect: The Art of Interactive Narrative*. Pearson Education.

Meier, S. (2012). *Interesting Decisions*. Presented at the GDC 2012, San Francisco. Retrieved from http://www.gdcvault.com/play/1015756/Interesting

Morrison, B. (2013, November 19). Gamasutra: Brice Morrison's Blog - Meaningful Choice in Games: Practical Guide & Case Studies. *Gamasutra*. Retrieved December 16, 2013, from http://www.gamasutra.com/blogs/BriceMorrison/20131119/204733/Meaningful_Choice_in_Games_Practical_Guide__Case_Studies.php

MozzieMineCraft. (2010). *Minecraft Enterprise NCC-1701-A walk around*. Retrieved from http://www.youtube.com/watch?v=58oP0WJn3BM&feature=youtube_gdata_player

Murray, J. H. (1998). *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. The MIT Press.

Nelson, M. J. (2011). Game Metrics Without Players: Strategies for Understanding Game Artifacts. In *Artificial Intelligence in the Game Design Process*.

O4NT.nl. (2013). O4NT.nl Onderwijs voor een Nieuwe Tijd. O4NT.nl.

Overmars, M. (1999). *GameMaker: Studio*. YoYo Games.

Permutation. (2014, July 5). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Permutation&oldid=613292991

Persson, M. (2009). *MineCraft [Beta]*. PC: Mojang Specifications. Retrieved from http://www.minecraft.net/download.jsp

Poorthuis, G. (2013). Hoe gevaarlijk is de digitale school? *HP/De Tijd*. Retrieved October 18, 2013, from http://www.hpdetijd.nl/2013-04-11/hoe-gevaarlijk-is-de-digitale-school/

Prensky, M. (2006). *Don't Bother Me Mom--I'm Learning!* Paragon House Publishers.

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A Motivational Model of Video Game Engagement. *Review of General Psychology*, *14*(2), 154–66.

Przybylski, A. K., Ryan, R. M., & Rigby, C. S. (2009). The Motivating Role of Violence in Video Games. *Personality and Social Psychology Bulletin*, *35*(2), 243.

Raessens, J. (2006). Playful identities, or the ludification of culture. *Games and Culture*, *1*(1), 52.

Reeve, J., Jang, H., Carrell, D., Jeon, S., & Barch, J. (2004). Enhancing students' engagement by increasing teachers' autonomy support. *Motivation and Emotion*, *28*(2), 147–169.

Reeves, B., & Malone, T. W. (2007). *Leadership in Games and at Work: Implications for the Enterprise of Massively Multiplayer Online Role-playing Games*. Seriosity.

Reichard, L. A., Rozemond, S., Dijkhuis, J. H., Admiraal, C. J., te Vaarwerk, G. J., Verbeek, J. A., … van Braak, J. (2003). *Getal en Ruimte*. Houten: EPN.

Reiss, S. (2004). Multifaceted nature of intrinsic motivation: The theory of 16 basic desires. *Review of General Psychology*, *8*(3), 179–193.

Reiss, S. (2009). *The Normal Personality: A New Way of Thinking About People* (1st ed.). Cambridge University Press.

Rieber, L. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research and Development*, *44*(2), 43–58.

Rigby, C. S., Deci, E. L., Patrick, B. C., & Ryan, R. M. (1992). Beyond the intrinsic-extrinsic dichotomy: Self-determination in motivation and learning. *Motivation and Emotion*, *16*(3), 165–185.

Rigby, C. S., & Ryan, R. M. (2011). *Glued to Games: How Video Games Draw Us In and Hold Us Spellbound*. Praeger.

RTL Nieuws. (n.d.). iPad-school? Dom idee. *RTL Nieuws*. Retrieved October 17, 2013, from http://www.rtlnieuws.nl/nieuws/binnenland/column/rick-nieman/ipad-school-dom-idee

Ryan, R. M., & Connell, J. P. (1989a). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, *57*(5), 749–761.

Ryan, R. M., & Connell, J. P. (1989b). Academic Self-Regulation Questionnaire (SRQ-A). Retrieved from http://www.psych.rochester.edu/SDT/measures/SRQ_academic.php

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, *55*(1), 68–78.

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motivation and Emotion*, *30*(4), 344–360.

Salen, K., & Zimmerman, E. (2003). *Rules of Play: Game Design Fundamentals*. MIT Press.

Scheäfer, M. T. (2008). *Bastard Culture! User Participation and the extension of cultural industries*. Utrecht University, Utrecht.

Schmitz, C., & Cleeland, J. (2003). *LimeSurvey*.

Schreier, J. (2013, June 26). Sid Meier: The Father of Civilization. *Kotaku*. Retrieved December 16, 2013, from http://kotaku.com/the-father-of-civilization-584568276

Sciarone, A. G. (Ed.). (2004). *De Delftse methode nader bekeken*. Boom.

Shaffer, D. W. (2008). *How Computer Games Help Children Learn*. Palgrave Macmillan.

Shaffer, D. W., Squire, K., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi Delta Kappan*, *87*(2), 104–111.

Sheridan, M. D., Howard, J., & Alderson, D. (2010). *Play in Early Childhood: From birth to six years.* London: Routledge : [distributor] Taylor & Francis, c/o Bookpoint.

Sihvonen, T. (2009). *Players Unleashed!: ModdingThe Sims and the Culture of Gaming.* University of Turku, Turku.

Silver, H. F., Brunsting, J. R., & Walsh, T. (2007). *Math Tools, Grades 3-12: 64 Ways to Differentiate Instruction and Increase Student Engagement.* Corwin Press.

Silver, H. F., Strong, R. W., & Perini, M. J. (2000). *So Each May Learn: Integrating Learning Styles and Multiple Intelligences.* ASCD.

Simons, R.-J., Linden, J. van der, & Duffy, T. (2000). *New Learning.* Springer.

Singer, D. G., Golinkoff, R. M., & Hirsh-Pasek, K. (2006). *Play = Learning: How Play Motivates and Enhances Children's Cognitive and Social-Emotional Growth* (1 edition.). Oxford University Press, USA.

Slavich, G. M., & Zimbardo, P. G. (2012). Transformational Teaching: Theoretical Underpinnings, Basic Principles, and Core Methods. *Educational Psychology Review*, *24*(4), 569–608.

Smith, M. R. (1994). *Does technology drive history?: the dilemma of technological determinism.* Cambridge, Mass.: MIT Press.

Springer, E. (2008). Moral Feedback and Motivation: Revisiting the Undermining Effect. *Ethical Theory and Moral Practice*, 11(4), 407–423.

Squire, K. (2008). Open-ended video games: A model for developing learning for the interactive age. *Open-ended video games: A model for developing learning for the interactive age*, 167–198.

Sutton-Smith, B. (1997). *The Ambiguity of Play.* Cambridge: Harvard University Press.

theinternetftw. (2010). *A 16-Bit Program Counter, Another 16 Bits of Memory, And One Dead Pig.* youtube. Retrieved from http://www.youtube.com/watch?v=iUjOg6EUgQs&feature=youtube_gdata_player

Tieben, R., Bekker, M. M. (Tilde), & Schouten, B. A. M. (2011). Curiosity and Interaction: making people curious through interactive systems. In *BHCI*. Presented at the BHCI 2011.

Trends in Gaming: Freedom of Murder. (2012). Retrieved from http://www.youtube.com/watch?v=QR4lwW7YHhU&feature=youtube_gdata_player

Van Ernst, A. (2002). *Koop een auto op de sloop.* APS.

VandenBerghe, J. (2012). *The 5 Domains of Play: Applying Psychology's Big 5 Motivation Domains to Games.* Presented at the GDC 2012, San Francisco.

Vella, J. (2002). *Learning to Listen, Learning to Teach: The Power of Dialogue in Educating Adults.* John Wiley & Sons.

Verenikina, I. (2003). Understanding scaffolding and the ZPD in educational research. In *Australian Association of Educational Research Conference, Auckland, New Zealand.*

Verhulst, F. (2003). *De Ontwikkeling van het Kind* (7th ed.). Assen: Koninklijke Van Gorcum.

Vlambeer. (2011). Make a Game-day. vlambeer.com. Retrieved May 27, 2014, from http://www.vlambeer.com/2011/06/02/make-a-game-day/

Vygotsky, L. S. (1978). *Mind in Society: Development of Higher Psychological Processes* (New edition.). Harvard University Press.

Waring, R. (2006). Why Extensive Reading should be an indispensable part of all language programs. *Forthcoming in The Language Teacher.*

Windell, T. (2001). Shattered. *StarTrek: Voyager.*

Yee, N. (2006). Motivations for play in online games. *CyberPsychology & Behavior*, *9*(6), 772–775.

Yee, N., & Bailenson, J. (2007). The Proteus Effect: The Effect of Transformed Self-Representation on Behavior. *Human Communication Research*, (33), 271–90.

ZenicReverie. (1983). Math Gran Prix for Atari 2600 (1982). MobyGames. Retrieved November 19, 2013, from http://www.mobygames.com/game/math-gran-prix/

Xun, G. E., & Land, S. M. (2004). A conceptual framework for scaffolding III-structured problem-solving processes using question prompts and peer interactions. *Educational Technology Research and Development*, 52(2), 5–22.

LUDOLOGY

5th Cell. (2009). *Scribblenauts*. Nintendo DS: Warner Bros. Interactive Entertainment.

Atari Inc. (1982). *Math Gran Prix*. Atari 2600: Sears, Roebuck and Co.

Avalanche Studios. (2010). *Just Cause 2*. Xbox360: Eidos Interactive.

Avalanche Software. (2013). *Disney Infinity*. Xbox360: Microsoft Studios.

BioWare. (2007). *Mass Effect*. Xbox360: Microsoft Game Studios.

BioWare. (2010). *Mass Effect 2*. Xbox360: Electronic Arts.

Bizarre Creations. (2003). *Geometry Wars: Retro Evolved*. Xbox360.

Blizzard Entertainment. (1998). *StarCraft*. PC: Blizzard Entertainment.

Blizzard Entertainment. (2004). *World of Warcraft*. PC: Blizzard Entertainment.

BrainPOP. (2014). *Go Vector Go*. PC: BrainPOP.

BudgeCo. (1985). *Pinball Construction Set*. PC: Electronic Arts.

Capcom. (1991). *Mega Man II*. GameBoy: Capcom.

Capcom. (1996). *Resident Evil*. PlayStation: Capcom.

Chen, J., Clark, N., & Wintory, A. (2006). *Flow*. PC: Chen, Jenova.

Core Design. (1995). *Tomb Raider*. PC: Eidos Interactive.

Crowley, D., & Selvaduri, N. (2009). *Foursquare*. iOS.

Crystal Dynamics. (2008). *Tomb Raider: Underworld*. Xbox360: Eidos Interactive.

Davidson & Associates. (1994). *Math Blaster Episode I: In Search of Spot*. PC.

Deen, M., & Verhoeven, B. (2011). *Combinatorics*. PC: Fontys ICT.

Distinctive Software Inc. (1990). *Stunts*. PC: Brøderbund.

DMA Design. (2001). *Grand Theft Auto III*. PlayStation 2: Rockstar Games.

Dodge, B. (2007). WebQuest Research. *WebQuest*.

DragCube. (2014). Retrieved from http://youtu.be/I2lSiMNJL2M

Exidy. (1979). *Star Fire*. Arcade: Exidy.

Facepunch Studios. (2004). *Garry's Mod*. PC: Valve Corporation.

First World Studio. (2007). *Math Attack*. PC: First World Group.

From Software. (2009). *Demon's Souls*. PS3: Sony Computer Entertainment.

From Software. (2011). *Dark Souls*. Xbox360: Namco Bandai Games.

Game Freak. (1996). *Pokémon Red & Blue*. GameBoy: Nintendo.

Game Freak. (2013). *Pokémon X and Y*. N3DS: Nintendo.

GlassLab. (2013). *SimCityEDU*. PC.

Gygax, G., & Ameson, D. (1974). *Dungeons & Dragons*. TSR, Wizard of the Coast.

Larian Studios. (2009). *Monkey Tales: Monkey Labs*. PC: Larian Studios.

Ludomotion. (2014). *Sumico - the numbers game*. Android.

Maxis. (2000). *The Sims*. PC: Electronic Arts.

Maxis. (2008). *Spore*. PC: Electronic Arts.

Media Molecule. (2008). *LittleBigPlanet*. PlayStation 3: Sony Computer Entertainment.

Media Molecule. (2010). *LittleBigPlanet 2*. PlayStation 3: Sony Computer Entertainment.

MicroProse. (1991). *Civilization*. PC: MicroProse.

MolleIndustria. (2006). *McDonald's Videogame*. PC: MolleIndustria.

Monster Games. (2011). *Pilotwings Resort*. N3DS: Nintendo.

Motion Math (2013), *Motion Math: Zoom*. iOS.

Nintendo EAD. (1985). *Super Mario Bros*. Nintendo Entertainment System: Nintendo.

Nintendo EAD. (1992). *Super Mario Kart*. SNES: Nintendo.

Nintendo EAD. (2013). *The Legend of Zelda: A Link Between Worlds*. N3DS: Nintendo.

Nintendo, & Intelligent Systems. (2009). *WarioWare D.I.Y.* Nintendo DS: Nintendo.

Nintendo R&D1. (1989). *Tetris*. GameBoy: Nintendo.

Nintendo SDD. (2005). *Dr. Kawashima's Brain Training: How Old Is Your Brain?* Nintendo DS: Nintendo.

Number None, Inc. (2008). *Braid*. Xbox360: Microsoft Game Studios.

Origin Systems. (1997). *Ultima Online*. PC: Electronic Arts.

Project Soul. (2002). *Soulcalibur II*. GameCube: Namco.

Peta. (2013). *Super Chick Sisters*. PC.

Ranj Serious Games. (2009). *The Great Flu*. PC: Erasmus MC.

Ruiz, S. (2005). *Darfur is Dying*. PC: University of Southern California.

Russel, S. (1962). *Spacewar!* PC: MIT.

SassyBot Studio. (2014). *Fragments of Him: An Interactive Narrative Experience*. PC.

SkillPixels. (2013). *Eedu Elements*. iOS.

Smith, D. E. (1983). *Lode Runner*. Atari 8-bit: Brøderbund.

Sonic Team. (1991). *Sonic the Hedgehog*. Genesis: Sega.

Sora. (2008). *Super Smash Bros. Brawl*. Wii: Nintendo.

Sparpweed Games. (2013). *Ibb and Obb*. PC: Sparpweed Games.

Square. (1994). *Secret of Mana*. SNES: Square.

subLOGIC. (1982). *Microsoft Flight Simulator*. PC: Microsoft.

Super Chick Sisters spel. (n.d.). PC: FunnyGames.

Toca Boca. (2011). *Toca Store*. iOS.

thatgamecompany. (2009). *Flower*. PlayStation 3: Sony Computer Entertainment.

Turn 10 Studios. (2013). *Forza Motorsport 5*. Xbox360: Microsoft Studios.

Two Tribes B.V. (2008). *Toki Tori*. Wii: Two Tribes B.V.

Two Tribes B.V. (2011). *Toki Tori HD*. iOS: Chillingo.

Ubisoft Montpellier. (2006). *Rayman Raving Rabbids*. Wii: Ubisoft.

Valve Corporation. (1998). *Half Life*. PC: Sierra Studios.

University of Washington. (2008). Foldit. PC.

A

CASE STUDIES

This section is a collection of case studies of games that were referred to in this thesis. In order of succession it describes how *Super Mario Bros.* (Nintendo EAD, 1985), *World of Warcraft* (Blizzard Entertainment, 2004) *The Legend of Zelda: A Link Between Worlds* (Nintendo EAD, 2013) *Pokémon Red & Blue* (Game Freak, 1996), *Fingle* (GameOven, 2011) and *Bounden* (Game Oven & Dutch National Ballet, 2014) relate to theoretical framework for autonomy-supportive game design as discussed in this thesis.
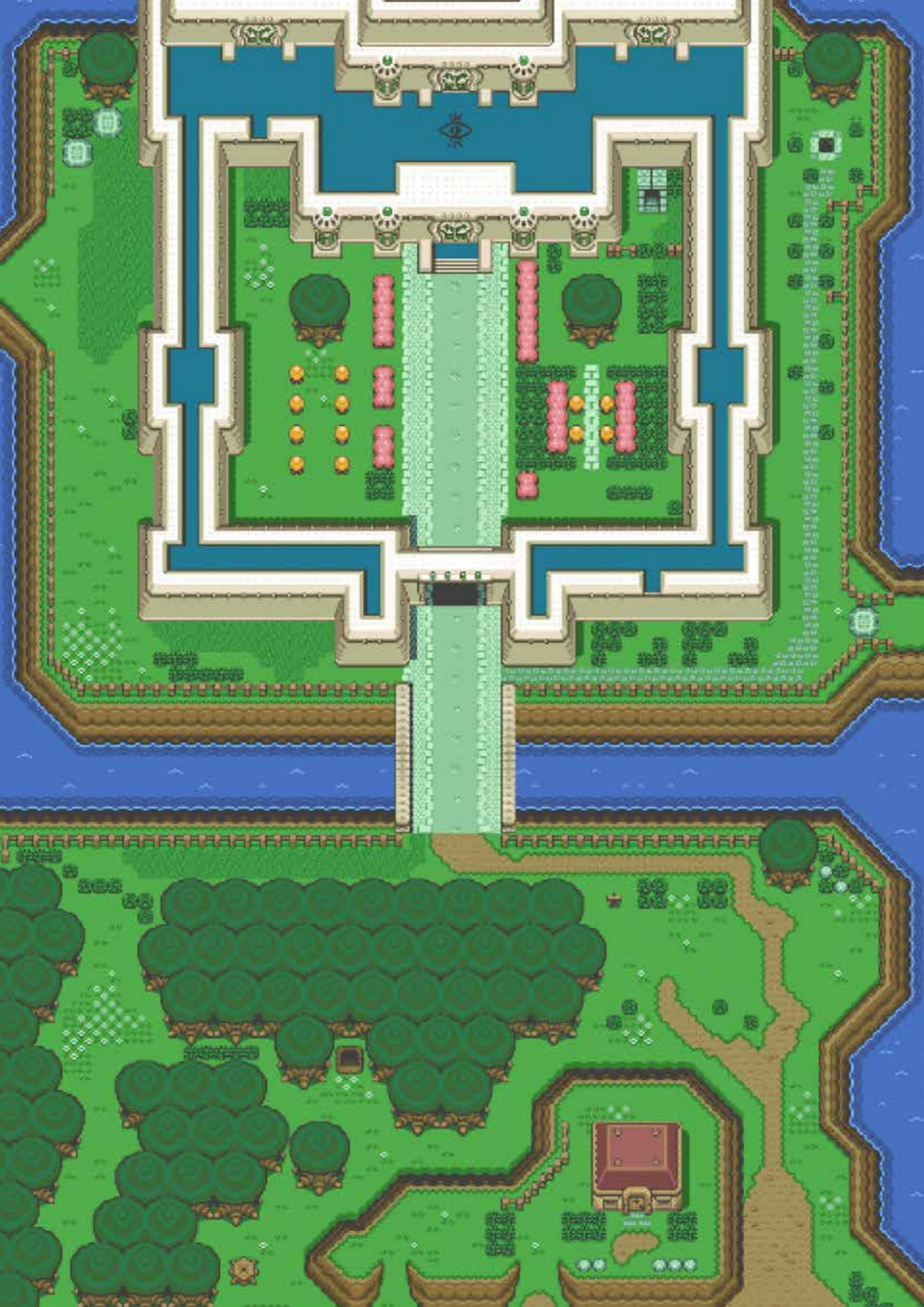
APPENDIX **CASE STUDIES**

The *Super Mario Bros.* case illustrates how Shigeru Miyamoto instructs and explains the main mechanics of the game by having players experiment, explore and struggle with the learning content. Miyamoto appears to adopt the teaching role of the facilitator throughout the game and uses external regulations to introduce new gameplay elements. *Super Mario Bros.*, although rather straightforward, can therefore be considered an autonomy-supportive game.

World of Warcraft builds forth on autonomy-supportive design by creating a free-roaming game environment that closely resembles the Zone of Proximal Development as discussed by Vygotski (1978). Additionally, the game excels in ways to satisfy needs for relatedness. Needs for relatedness is claimed to be a universal need which, if satisfied, can increase motivation to play (Przybylski, Rigby, & Ryan, 2010). One way of satisfying this need is through creating a social interdependency in the game. This interdependency will be elaborated upon.

The following section explains how the free-roaming aspects can be found in more rigid (or traditional) games. By discussing a transition of increased autonomy-support in *The Legend of Zelda* series, it will become clear how valuable the generation of one's own path can be to players and how this can be accomplished, even in the linear and straightforward structure of a narrative. In this section, the games *The Legend of Zelda: A Link to the Past* (Nintendo EAD, 1991) and its successor *The Legend of Zelda: A Link Between Worlds* illustrate this transition, which may be an indication for game design trends in the future.

The discussion of the *Legend of Zelda* series is followed by an elaboration of the motivational features embedded in *Pokémon Red & Blue*. To me, *Pokémon* is the pinnacle of motivational game design that dares to innovate but stays true to its core dynamics. This section describes how *Pokémon* incorporates the Zone of Proximal Development, Parallel Gameplay, Gameplay Sharing, Social Interdependency, and Multiple Solutions to one challenge and all four Playing Styles. What's more, it will become clear how *Pokémon* originated from a design process that started with the dynamics. Like the swim games-case, Satoshi Tajiri (the *Pokémon* designer) analyzed existing playful activities and created a game that facilitated social negotiation and self-expression within the context of the activity.
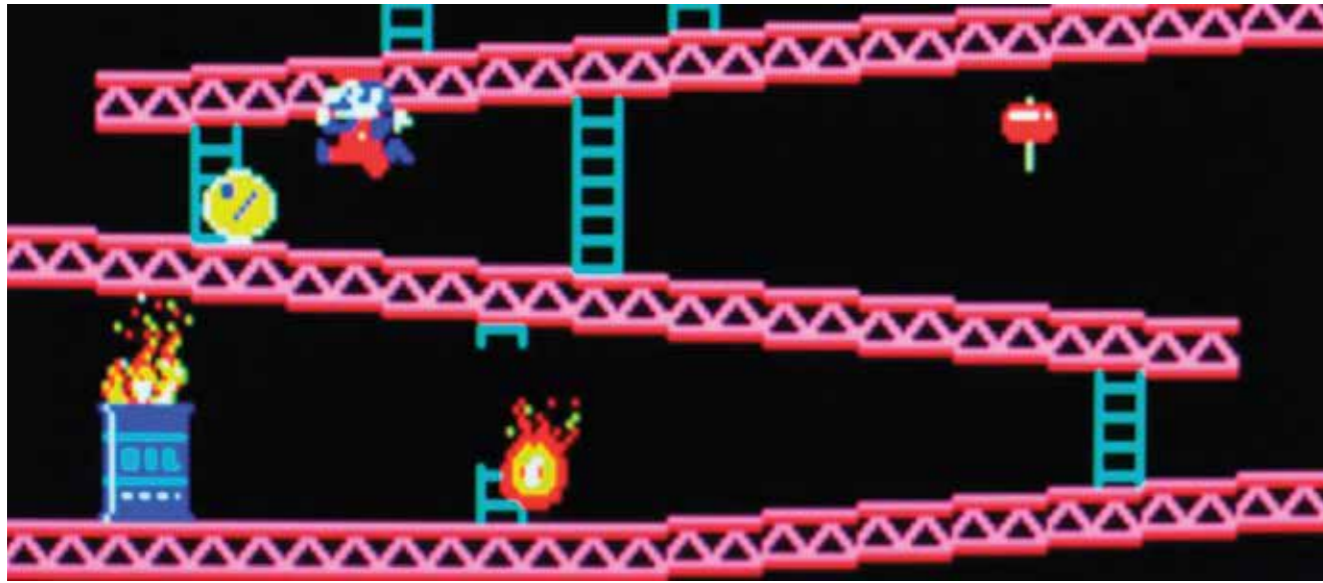
Figure 132: A screenshot from the Legend of Zelda a Link to the Past

The design-from-dynamics approach may result in very interesting and innovative games. Like Satoshi Tajiri, it appears that game designer Adriaan de Jongh went through a similar process when designing *Fingle* (GameOven, 2011) and *Bounden* (Game Oven & Dutch National Ballet, 2014). The last section will elaborate upon this design approach and show how it can elicit autonomy-supportive games that create new and unexpected experiences and gameplay.

SUPER MARIO BROS.
Nintendo EAD, 1985

Super Mario Bros. is probably the most famous side-scrolling platformer of all time. Since its launch in 1985 it spawned more than 15 successors, there have been various movie adaptations, and within five years of the launch, a national survey found that Mario was more recognizable to American children than Disney's *Mickey Mouse* (Iwabuchi, 2002). It is safe to say that Mario made an impact.

Mario made his first appearance as Jumpman in *Donkey Kong* (Nintendo, 1981). According to Kent (2001), *Donkey Kong*'s sales saved Nintendo from going bankrupt. In the game, players can move Jumpman with a joystick. One button makes Jumpman jump over barrels and small clefts.

Donkey Kong was such a success that its main gameplay (which did not concern the big gorilla) was translated to *Mario Bros.* (Nintendo R&D1, 1983). In this multiplayer arcade game, two plumbers (Mario and Luigi) try to stay alive and gather golden coins that fall into the sewer. Players needed to jump against the brick floors to topple a foe. Once upside down, foes could be kicked away. The game mechanics look very similar to those of *Donkey Kong*, with the difference that two players could play together and with the addition of killing foes. It appears that game designer Shigeru Miyamoto iterated upon this gameplay of jumping over foes, hitting bricks and gathering coins, when he designed *Super Mario Bros.*

Super Mario Bros. was intended for a different audience. Whilst *Donkey Kong* and *Mario Bros.* where played on an arcade, *Super Mario Bros.* was intended for the Family Computer or Famicon (Gorges, 2012). This meant that Nintendo was targeting a different audience. The arcade machine monetized on 'coin-drops' in public spaces.

Figure 133: Donkey Kong introduced Jumpman, later known as Mario

Figure 134:Super Mario 3D World is the latest installment in the Super Mario franchise

Game designer Ed Logg (2012) explains that in this Coin-Operated industry (Coin-op), people paid 25 cents per play. A play session lasted for merely ninety seconds to two minutes. This meant that designers were tasked to create an engaging experience with a strong focus on replayability. The play sessions of a typical arcade game may therefore be fast paced, short and easy to understand. The use of a single screen to portray the whole play area might have come from the necessity to explain the game in mere seconds to people passing by.

In comparison, games on a home console ask for a very different approach. Home players tend to have more time on their hand. According to the website HowLongToBeat.com, *Super Mario Bros.* takes two hours to complete, while its latest adaptation *Super Mario 3D World* (Nintendo EAD Tokyo, 2013) takes roughly 32 hours to complete. Glueing players for longer periods of time to a screen asks for a different design approach than giving them short and intense play-sessions of minutes. One way of accomplishing this is by playing upon players' curiosity (Malone, 1981), sense of competence, and autonomy, and by developing intuitive controls (Przybylski et al., 2010). *Super Mario Bros.* appears to do this very well. Miyamoto does a splendid job in teaching players how to play without resorting to instructional texts or tutorial levels (modeling the teaching role of the explainer).

Autonomy-supportive scaffolding in SMB.
Super Mario Bros. may be one of the best examples of a well-scaffolded game that still presents players the opportunity to explore, experiment and struggle with the game mechanics. It already starts in the very first seconds of the game. Players hit start to play, and are dropped in the Mushroom Kingdom. Intuitively players will move to the right (in accordance to their preferred reading direction), and because Mario is situated on the left side of the screen.
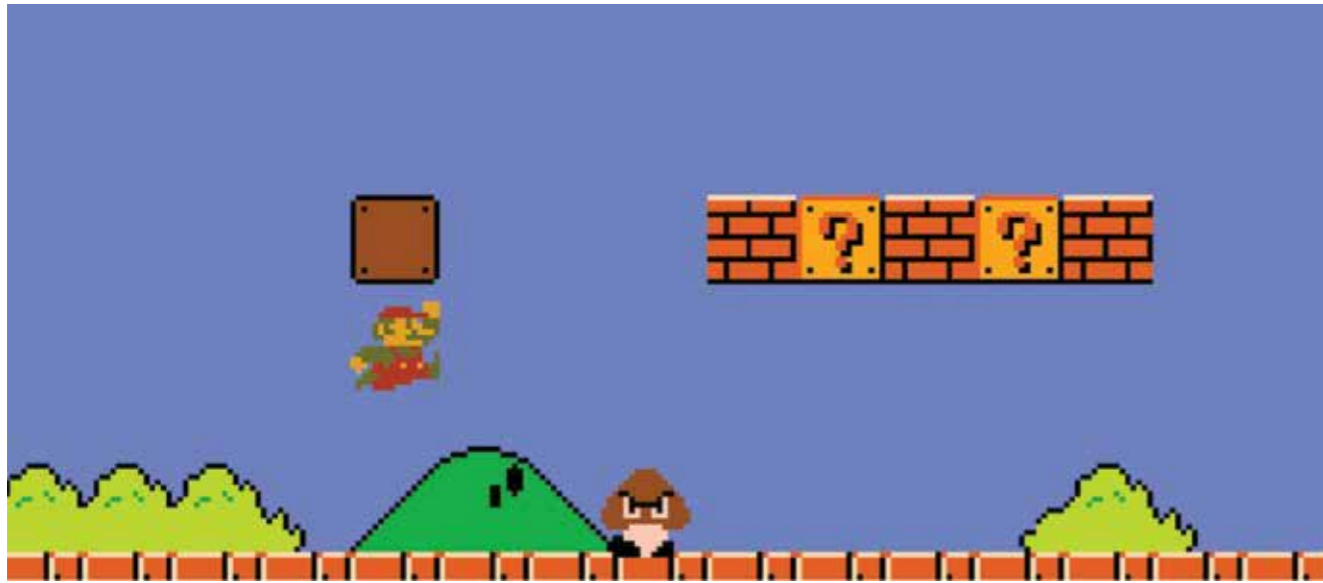
Within a second, a Goomba appears. If players fail to hit the jump button, Goomba runs into Mario, resulting in immediate death. In a second try, players will probably find the jump button after struggling with the game controller. They move to the right, hit jump and find themselves jumping over Goomba. Their (second) jump will probably position Mario under a brick, which is conveniently hanging in thin air. Jumping against the brick results in the growth of a Magic Mushroom. At that moment, Mario is stuck underneath a row of bricks and can only move forward to the right, as does the mushroom. After growing out the brick, it moves to the right, falls down, hits the sewer pipe and moves back towards Mario.

It is almost impossible to avoid running into the Mushroom. Upon impact, Mario transforms into Super Mario (a larger version of himself). Super Mario is able to break bricks, which the player will probably do, since it may be hitting the jump button frantically to avoid the mushroom at first. Within four seconds, players learn that Goombas are foes (and deadly to run into), bricks can hold items, some items can help Mario grow stronger, and Super Mario can break 'empty' bricks by jumping against them.

Without any textual instruction, Miyamoto educated players about the basic mechanics of *Super Mario Bros.* He accomplishes this in a very autonomy-supportive way, by having players experiment (walking into a Goomba), explore (suggesting that there is a whole world on the right of the screen, outside the player periphery) and struggle with the game's controls (frantically hitting every button on the controller to find out what they do). Still, this autonomy-supportive learning is based on a strong external regulation: 'Conform or die'. However, as the game progresses, players are giving more leeway and opportunities to explore the world. The flagpole example illustrates this well, as do the warp-zones in other levels. A warp-zone is a difficult to reach room where Mario can enter a pipe and transport to a particular level.

Super Mario Bros. remains a rather rigid game, especially in comparison to today's free-roaming and sandbox games. Nonetheless, Miyamoto appeared to strike a well-designed balance between educating players in the game and offering them freedom to explore, experiment and struggle with game and its playful environment. It may be this synergy in satisfying needs for competence and autonomy that makes Super Mario Bros. such an engaging game.

Figure 135: Super Mario Bros. first seconds by thelimomon. deviantart.com

Figure 136: The Mage (Damage Dealer), Warrior (Tank) and Priest (Healer) in World of Warcraft

WORLD OF WARCRAFT
Blizzard Entertainment, 2004

World of Warcraft is a Massively Multiplayer Online Role Playing Game (MMORPG) set in the fantasy world of the Warcraft Universe. This world closely resembles Tolkien's world of Middle Earth, filled with elves, trolls, gnomes and humans. Later additions included 'steam punk' features and science fiction-related characters and environments. Players pay a subscription to log onto a server and wander the three-dimensional world, conquer dragons, and slay monsters. With more than hundred million accounts created over the game's lifetime, 10 million copies sold and grossing over 10 billion USD dollar (Douglas, 2012), *World of Warcraft* can be considered the most popular MMORPG to date.

Players in *World of Warcraft* choose a race (e.g. gnome, elve, orc), class (e.g. mage, warrior, priest) and gender before entering the virtual world. Once there, players are tasked to traverse the world and use their class-depending powers to challenge foes. For example, Mages can fire magic spells if the player hits a self-assigned number on the keyboard. Once the button is hit, players have to wait until the attack is recharged. Mages typically try to fight monsters from a distance. They throw a powerful magic spell towards a wandering foe from a far, doing significant damage to the foe's health bar. When attacked, foes counter-attack and move towards the players' character. Before foes have time to do any damage, players have recharged their attack and fire again, this time finishing the foe.

The corpses of foes can be looted. Most foes hold small items that can be used to enhance a character's gear or stats. Others hold weapons or gear that players can attach to their character. Some items improve overall stamina, giving characters more health points, making them more able to receive and survive damage. Mage players typically search for items that increase their character's intellect. The more intellect, the more powerful the Mage's magical attacks.

Every class has a different playing style. For example, warriors can take many hits but do little damage. That is why warriors prefer items that increase their defensive power. They run up to foes and strike them from up close. In comparison, Mages can do significant damage but are rather fragile. They tend to fight foes from afar, timing their attacks strategically.

Lastly, Priests can heal other characters and themselves. Like Mages, they rely highly on items that give them higher intellect (stronger magical spells) or spirit (faster regeneration of health and mana). Priest's healing powers make them very popular in groups of players. While a warrior is keeping enemies at bay, Mages can deal damage, and Priests can heal the warrior; creating a formation of tank (Warrior), damage dealer (Mage) and healer (Priest). This makes for a strategically triangular formation, giving these players an edge over solo players when it comes to conquering higher-level enemies.

Every enemy and every character in *World of Warcraft* has a level. These levels depict the basic stats of the character. Stats is an abbreviation for statistics, amongst others they describe the level of stamina, strength, spirit and intellect. For example, a level 1 Mage (Draenei) has a base intellect of 23 and 165 mana. Every time a foe of corresponding level is defeated, the character gains experiences points. When a certain amount of points is reached (players have engaged in a particular amount of battles), characters 'level-up'. Going from level 1 to level 2, means an increase in stats. Characters become stronger and can fight higher-level enemies.

The Zone of Proximal Development and Interdependency
The world of *World of Warcraft* is divided into various areas. Every level has a 'level-cap'. This means that every area holds foes from a particular level. For example, Elwynn Forest is a level 1 to 10 environment; Westfall is level 10 to 20 and Duskwood 18 to 30. Players can wander these areas in relative safety when they traverse the roads. However, wandering off the roads will often mean that characters are attacked by foes. A level 1 Mage will stand little change in Duskwood fighting level 19 wolves. First the Mage needs to level-up by killing other foes that correspond with its own level.

Blizzard designed various 'optimal' leveling routes through the game. They mainly consist of quests. Non-attacking characters in the game can task players to kill, for example, an *x* amount of Kobolds in a nearby cave or loot an *x* amount of items from a nearby Murlocs. By killing foes and finishing quests, players gain experience, growing stronger and unlocking new and more difficult attacks. These grinding exercises train the player in timing their attacks correctly. They come to understand where to position their characters and how to move around. Questing makes players more proficient. A players' characters' level therefore signifies the proficiency of the character and the player.

World of Warcraft is a well-scaffolded game, but appears less rigid in design than *Super Mario Bros.* The opportunity to traverse through higher-level areas for example shows how players are free to explore the boundaries of their proficiency. As a level 4 Mage I once traveled all the way to *Winterspring*, a level 50-55 area. I asked other players to guide me there and keep monsters away from me. It turned out to be a very satisfying activity. This shows the open character of *World of Warcraft*. Players can play (and learn how to play) in so many ways, and on so many levels that the design can be considered a Zone of Proximal Development, creating an autonomy-supportive environment that stimulates (not enforces) competence development.

One major aspect of *World of Warcraft* is the competence development of teamwork. As described above, it is stimulated to make teams that consist of a tank, damage dealer and healer. This formation resembles a rock-paper-scissors design pattern (Bjork & Holopainen, 2004). However, whereas Rock-Paper-Scissor suggests a competitive pattern of interdependence, the interdependence between tank, damage dealer and healer is more cooperative. This social interdependency can satisfy needs for relatedness, which, according to Ryan & Deci (2000) is a strong motivator.

World of Warcraft is an interesting example of the implementation of the Zone of Proximal Development. It offers players a chance to stray from the path, engage with tasks that are above their competence level, and at the same time offers a well-scaffolded path that builds players competence in play. Additionally, the ability to play with (higher leveled) others, ask for help or lend a hand, has strong motivational and educational aspects to it. *World of Warcraft* does a very good job in satisfying all three human needs: competence, autonomy and relatedness (Ryan & Deci, 2000), which may be the reason for its commercial success. Personally, I find the autonomy-support and the social negotiations that take place in this game, the most interesting and challenging aspects to design for.

THE LEGEND OF ZELDA: A LINK BETWEEN WORLDS
Nintendo EAD, 2013

The Legend of Zelda: A Link to the Past (Nintendo EAD, 1991) is an epic story about kings, queens, destiny, faith and elves. It puts the player right in the middle of becoming the Hero of Legends, better known as Link. *Zelda III* (as Zelda fans tend to call the game) is by far my most favorite game of all time. I spend hours unraveling all secrets hidden in the game. I replayed dungeons with only one health-heart left, in order to increase the challenge. I even picked up a French dictionary to translate the game's conversations into Dutch (I played the French version). And wrote a complete walkthrough of the game, illustrated with screencaptures from magazines. It is safe to say that the game had a huge impact on me. Up until now, I have not found a game that motivated me so deeply to explore, experiment and struggle with its challenges. I feel that, in addition to aforementioned elements, my most engaging factor in *Zelda III* was that the game allowed me to create my own path through the game.

In *Zelda III*, Link needs to save the Seven Maidens. Every maiden is imprisoned in a dungeon and guarded by an end-boss. These guards are typically defeated by an item, which can be found in its respective dungeon, or by an item that is a perquisite to enter the dungeon in the first place. For example, during Links adventures in the Dark World, players will find a Fire and Ice Rod. Link can shoot fire and ice with these respective rods. The Fire Rod gives Link access to the Skull Woods dungeon. Players have to fire the rod on the entrance to create passage. *Zelda III* is filled with these kinds of puzzles. As a player, I often tried to obtain all items first, and then revisit a dungeon in order to defeat its end-boss. Defeating a huge monster with one hit of an overpowered weapon was rather satisfying. I felt as if I was beating the system, I felt like outsmarting the designers, and most of all, I felt in *control*.

In *Zelda III*, I could create my own path through the game. I was able to self-determine the difficulty level of a dungeon and play in my very own way. I could go into battle heads-on, killing enemies without a strategy. Or I could analyze enemies' movement, take a long-range weapon (bow and arrow) and lay foes down one by one. I even felt that I could cheat the system. For example, in the Tower of Hera, Link stumbles upon a room with Flying Tiles. If Link stands in a doorway, he can avoid all Flying Tiles, allowing them to ricochet harmlessly off the wall.

Figure 139: Players of Zelda III can travel through Hyrule in various ways

Figure 140: In Zelda III-2 players can buy (almost) all weapons at the start of the game

All these gameplay elements empowered me as a player, I felt that what I did in the game mattered, it was meaningful to me because I was in control. I felt like an autonomous individual exploring, experimenting and struggling with the challenges thrown at me by the game designers.

The autonomy-support in *Zelda III* is what makes the game so compelling to me. The game invited me to revisit it, over and over again. I kept asking myself, what if I do this, or what if I do that, how will it affect the game or my experience? *Zelda III* allows for this autonomous exploration. In *Zelda III* I could express and explore my interests, volition, goals and values.

Generating one's own path through a *Zelda III-2*
More than two decades later, Nintendo released an official successor to *Zelda III*: *The Legend of Zelda: A Link Between Worlds* (Nintendo EAD, 2013). The game takes place in the same world as its predecessor, and roughly follows the same story arc: First gather three pendants, than go to the 'other world' and free seven sages. Like Zelda III, this edition contains dungeons that can be entered and completed with a particular item. However, in contrast to its predecessor, Link has access to all items at the very beginning of the game. Players can self-determine which dungeon they enter and in which succession they complete the game. Still, there are a couple of major plots to follow. Nonetheless, the game offers players more freedom than *Zelda III* did.

The designers of In *Zelda III-2* purposefully choose to present players with more agency than in its predecessor. Hereby they broke with the strong conditional structure (first this, than that, and with that you can do this) that characterizes the series. Aside from *Zelda I*, *Zelda II*, *Zelda III* and *Zelda III-2*, Nintendo released twelve other Zelda games. In all games, players start without any items, butslowly learn how to gain and use the items. The conditional structure in the Zelda series was utilized to scaffold the game's difficulty. However, *Zelda III-2* shows that the ability to generate one's own path may be even more engaging than becoming a good player.

POKÉMON RED & BLUE
Game Freak, 1996

Pokémon could very well be called: 'GameBoy's Savior'. With declining sells in the mid-90s, Nintendo's mobile gaming system was slowly falling into oblivion. It was hard to compete with the prowess of Sony's PlayStation and the Personal Computer. Disappointing sales of Nintendo's N64 (the successor of Nintendo's highly popular Super Nintendo Entertainment System) and the VirtualBoy (Nintendo's failed attempt to bring virtual reality into the living room) pushed Nintendo to invest in a new 'killer app'. They got Pokémon and brought forth a game series that brought innovations to the game industry with every new sequel.

With more than 23 million copies sold worldwide, the GameBoy-exclusive-title pulled Nintendo's outdated game platform out of the doldrums. The game series sprang its own television show that is still airing new episodes (840+ up until now) and is in syndication on many TV channels and online platforms. 17 full-length movies have been produced about Ash Ketchum (Satoshi in Japanese) and his companions on a quest to become Pokémon master. On top of that, more than 700 comic books on Pokémon were published in the last two decades. In addition to the immeasurable amount of merchandise, the Pokémon Trading Card Game may have been the biggest cash-cow for the franchise. Although the cards are initially designed to play an elaborate game, they were mainly gathered as collectibles by children, whom were stimulated to buy new 'booster packs' by the trademark's catchphrase: 'Gotta Catch 'Em All'.

'Gotta Catch 'Em All' is also the main premise of the Pokémon games. Satoshi Tajiri the designer of Pokémon was inspired by his childhood activity of catching bugs. He translated this to a game of catching small monsters, train them and have them fight with other monsters. He used the GameBoy's link-possibility to trade digital monsters between two apparatus. Some pokémon could be caught in the *Red* edition, whilst others where only available on the *Blue* cardridge. Players needed to trade pokémon in order to 'catch' them all. Although the Game Link Cable was used by 200+ games for multiplayer purposes, players seldom used this functionality. With Pokémon's ability to trade digital monsters between players, the Game Link Cable was revived and brought something new to mobile gaming: collaboration and sharing.
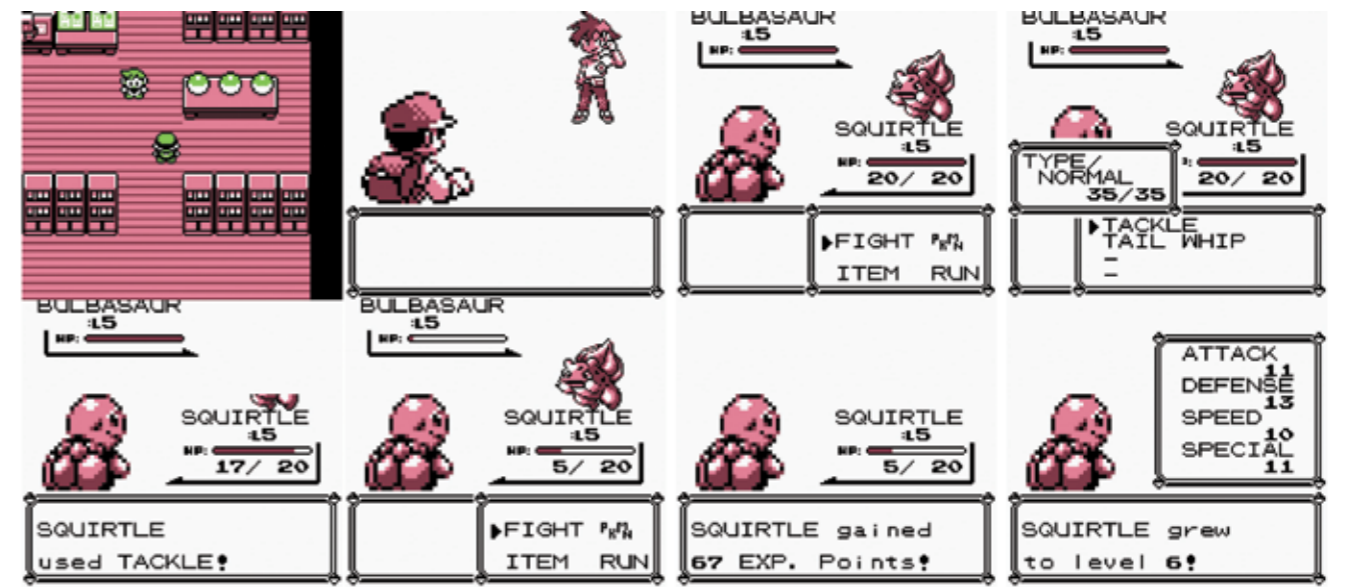
The first 151 pokémon were a big hit in Japan and were localized for a western market within two years. In four years, Pokémon became a worldwide phenomenon, adorning airplanes and cars with the anime series' favorite, a mouse-like creature: Pikachu, and selling to the youngest of children. In some countries the spin-offs appeared more popular than the original game. For example, in Israel the television series and Trading Card Game was introduced before Nintendo launched the game, making the Trading Card Game more popular than the original video game was (Tobin, 2004).

Player of Pokémon can move a character around in a world that is seen from a birds-perspective. If they wander into tall grass, they might walk into a wild pokémon. This is a random encounter, which changes the players' perspective from birds-eye to a third person view. The wild pokémon is positioned in the right upper corner of the screen, and the player's character is positioned in the left lower corner.

After a small animation, the player is replaced by its pokémon. Both pocket monsters have a bar that dictates their health score. The player can choose to Fight, Run, check one's Items or Change Pokémon. By choosing to fight, the players' pokémon can attack with four different moves. Choosing one of them results in a small animation where both pokémon attack each other in turn. A successful attack decreases the pokémon health bar. If the health bar of one of the pokémon is depleted, it faints. The pokémon still standing wins, and it gains experience points.

Experience points are used to raise a pokémon level. Levels indicate the value of a pokémon base statistics. Amongst others, pokémon have stats that include strength, health and speed. Strength determines the attack power in combination with the power of the attack itself. For example, choosing the attack 'flamethrower' does more damage than 'ember'. Health determines the amount of Health/Hit points a pokémon has, explaining its ability to withstand attacks. Speed determines the order in fights. The pokémon with the highest speed attacks first. In summary, the stats of a pokémon determine its strength in battle. However, a lower level pokémon can still win from a higher level. This depends on the pokémon type.

In *Pokémon Red & Blue* there are fifteen different types of pokémon. Amongst others there are grass-type pokémon, fire-type and water-type. grass-type pokémon have an advantage over water-type. If they attack with a grass attack (i.e. leech seed, leaf blade, solar beam) the water-type pokémon will receive twice the normal damage. In turn, if the water-type attacks a grass-type the attack power is significantly reduced. This is the core mechanic of the Pokémon series. Grass is strong against water, water has an advantage over fire, and fire has an advantage over grass-type pokémon. This Rock-Paper-Scissors formation invites players to create a balanced team of pokémon.

Players can create a pokémon team by catching wild pokémon. A pokémon is captured with a pokébal. In order to successfully capture a pokémon players need to reduce (not deplete) the wild pokémon health bar. A successful catch depends on the amount of health and other parameters. For example, some attacks (i.e. sleep powder, hypnosis) put pokémon to sleep. Sleeping pokémon cannot attack during their turn until they wake up, giving the attacking pokémon a huge advantage. Additionally, the catching rate of sleeping pokémon dramatically increases, making them easier to catch.

The designers of Pokémon have created a rather complex and extensive game based on the Rock-Paper-Scissors formation above. In the last two decade, the amount of different species has dramatically increased from 151 to 721 different species (*Pokémon X & Y* (Game Freak, 2013)). It is for this reason that fans build pokémon-encyclopedia, better known as a pokédex. The website serebii.net (Serebii.net, 2014) is an extensive database that gives insights in the stats of every pokémon. Players can also find information about pokémon evolution patterns. The latter is deemed important to many players, since pokémon change into another pokémon on a certain level. This is called pokémon evolution, and gives a great boost to the stats of a pokémon.

In summary, Pokémon may be the most compelling and successful game series of the last two decades. The series has built upon a core mechanic of interdependency (water-fire-grass) and creates a rich and diverse world that connects players from all over the world. The next section describes how the design guidelines from section 9 can be deduced from this game series. This partly explains its possible appeal for such a big audience.

Figure 143: Pokémon Red & Blue's starter pokémon, Bulbasaur (grass-type), Charmender (fire-type) and Squirtle (water-type)
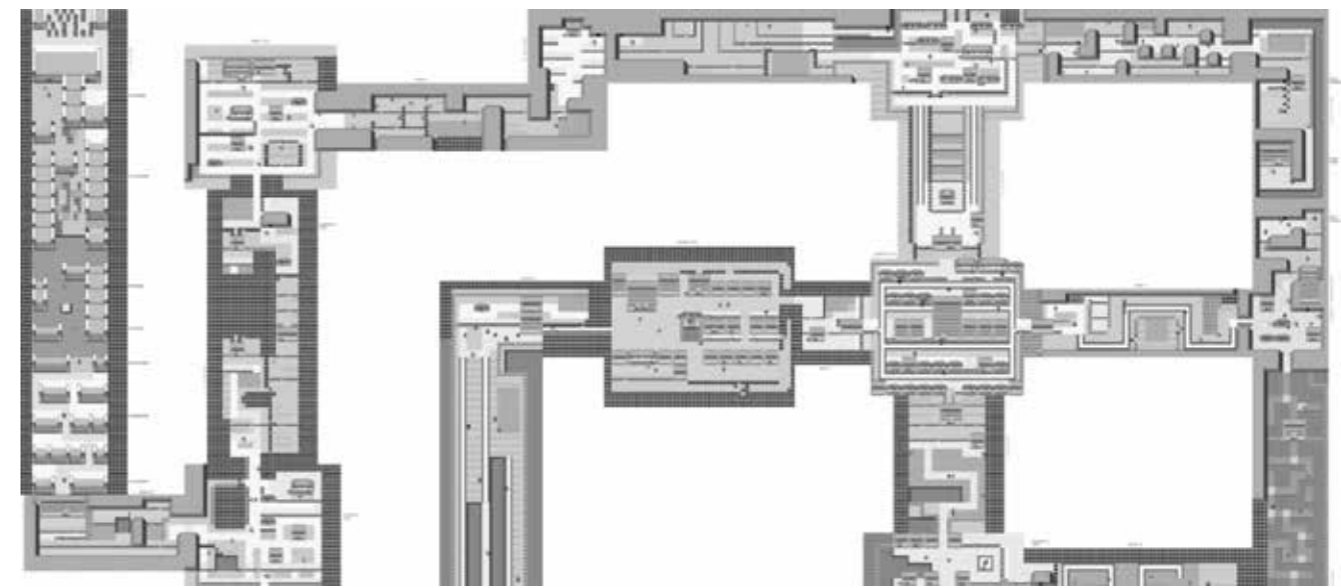
Figure 144: Pokémon Red & Blue's world map

Pokémon and the Zone of Proximal Development

The Zone of Proximal Development is an autonomy-supportive design tool to scaffold the learning of the player. It creates an environment in which players can self-depict what and when to learn. Still, it still breaks down the learning content to easy to manage parts. In Pokémon, players start with one pokémon. This is a pokémon that cannot be found in grass. The starter-pokémon base-stats are better than most pokémon found in the wild. This gives players an advantage in the beginning of the game over other pokémon. As a result, players can experiment, explore and struggle with game mechanics, since it is rather unlikely that they will lose the first battles.

Most of the Kanto region (the world of *Pokémon Red & Blue*) is free to explore, much alike the level areas of *World of Warcraft*, in which some areas are too hard for players. However, in contrast to *World of Warcraft,* some areas of the Kanto region are closed to the player at first. These areas can only be traversed if a particular item is found or when players carry a certain pokémon. For example, water areas can only be crossed if players have a water-type pokémon that knows the move 'surf', or players can only find transit through a dark tunnel if they carry pokémon with the move 'flash'.

Pokémon's world design and the increase of difficulty closely resembles that of *World of Warcraft*, and appears to borrow the conditional structure to obtain area access from *The Legend of Zelda* series. This is not surprising, since Satoshi Tajiri worked on Zelda games in the past. The relatively open structure of the game, and the carefully designed growth in difficulty setting, show how *Pokémon Red & Blue* managed to create an environment that is well-scaffolded and still autonomy-supportive. In other words, the game world corresponds to the Zone of Proximal Development, satisfying needs for autonomy and competence.

Parallel play, gameplay sharing and interdependency

Pokémon Red & Blue are stand-alone games and can be played through separately. However, the mere existence of a different edition makes players very aware of the fact that others are playing the same game. They are not playing alone, They are playing in parallel. This was especially true in family settings, where sibling owned their own device and edition. Although Pokémon players may not interact directly, this parallel play creates a sense of belonging, and thus satisfies needs for relatedness.

Needs for relatedness are further satisfied by trading pokémon with the Game Link Cable. Players could connect one device to another and trade one pokémon with other players. Hereby they send a pokémon with a particular set of attacks to another player, indirectly sharing their way of raising a pocket monster. This gameplay sharing was brought to fruition though multiplayer battles as well. Although the multiplayer battles did not present pokémon with extra experience, players could match their game capital with others. Gameplay sharing did not only happen inside the game (ie, on the cartridges).

Since its launch, fans have dedicated their time and energy to share walkthroughs, cheats, pokémon team formations, fan art, etc. on blogs and video sharing sides. Lastly, the developers organized real-life events, where players could battle and trade their pokémon, bringing players together to share stories and strategies.

Trading pokémon is one of the key aspects of the game. The trading is mandated if players wish to collect all 151 pokémon. Some pokémon are not available in both versions. For example, Growlith, Arcanine and the popular Scyther are only available in the *Red* version. In turn, Pinsir, Vulpix and Magmar were exclusive to the *Blue* edition. In order to receive these pokémon, players were dependent on other players (or editions). Additionally, some pokémon only evolve when traded. For example, Haunter can only evolve in Gangar, if traded. Lastly, trading pokémon have a slight advantage above non-traded monsters. A traded pokémon will gain more experience points and will therefore grow faster.

The trading feature makes players interdependent, as long as they do not own two editions and two GameBoys, players need to find others to trade. This interdependency is induced by the game, and appears to inspire players to bring it to another level. Last year witnessed a remarkable event in which multiple players controlled one game through the video streaming website *Twitch* (Justin.tv, 2011). Users could send commands though the chat room, which were parsed to the (emulated) game.

On the 12th of February an anonymous programmer started the experiment. Together with an estimated amount of 1.16 million people, they completed *Pokémon Red* on the 1st of March (total playtime: 16 days, 10 hours, 4 minutes, 4 seconds) ("Twitch Plays Pokémon," 2014).

Figure 145: With a Game Link Cable two Pokémon games can connect and exchange pokémon

Figure 146: Twitch Plays Pokémon screenshot

In this experiment players really needed to depend on others to move through the game. Due to the overload on inputs, the game's character was making endless turns and selecting the Helix Fossil (an item placed in the players' inventory at the very beginning of the game).

The *Twitch Plays Pokémon* event was never intended by the game designers, but emerged from social negotiations amongst players and fans. I suggest that the interdependency of Pokémon may have inspired the event, but of course, that is a long stretch and can even be considered farfetched. Nonetheless, the event shows how strongly an induced social interdependency can motivate players to invest time and energy.

Pokémon Red & Blue show how parallel play (two cartridges with slightly different version of the game), Sharing Gameplay (trading pokémon, online forums and databases, and battling other players through the Game Link Cable) and interdependency (exclusive pokémon in different editions, evolution through trade and the twitch event) can be very motivating. The satisfaction of needs for relatedness though these design tools appear highly engaging. The same appears true for the autonomy-support by offering different playing styles and multiple solutions.

Playing styles and multiple solutions
It may be clear that *Pokémon Red & Blue* offer various ways and manners to finish the game. Some players stick to the main narrative, follow a rather precise path to the end and finish the end-bosses (the Elite Four & Rival) with a cunning sense of strategy and vigor. Other players may grind for hours; battling as many pokémon they can endure in order raise their pokémon level to such a height that they easily overpower the pokémon of the Elite Four & Rival. It is safe to state, that *Pokémon Red & Blue* offer multiple solutions to one problem (not to mention all the different team combinations possible).

Every player can find and put something of /themselves in this game series. This is because the Pokémon series offer so many different ways to play the game. As such, they attune to all four playing styles depicted in section 3.3.5: 1) theoretical, 2) pragmatic, 3) interpersonal and 4) self-expressive styles of play (Deen, 2007). This section relates the playing styles to the Pokémon series.

Pragmatic players like a hands-on experience. They act before they think and learn through trial and error. In *Pokémon Red & Blue*, these players can be witnessed grinding through the game, gathering experience and rushing through the first eight gyms in no time. Every gym holds a 'gym leader', who corresponds to an end-boss in other games, since these pokémon trainers are the hardest to beat. A pragmatic player will probably not make it through the Elite Four & Rival in the first run. Instead, these players may lose the last battle (probably with the dragon type trainer) and return with enough 'potions' and 'revives' (items that can boost pokémon's status during and in between fights) to beat the game.

Theoretical players may choose a different approach. They enjoy crunching through numbers and databases, reading up on the best strategies before the play. In short, they think (or study) before they act. These players can be found consulting websites like GameFAQs (Jeff, 1995) or Serebii.net (Serebii.net, 2014), figuring out which team formation may prove the most strategic. They probably consult the in-game encyclopedia, the Pokédex, and love to dig into the stats of pokémon. Since every wild pokémon has different stats, they will catch several pokémon of the same species, compare their stats, and choose to train the pokémon that fits their strategy plan best.

Interpersonal players can be found playing Pokémon in parallel with others. They may enjoy the little conversations that in-game trainers have with the player's character and may enjoy the story arc of the game. Interpersonal players will probably hook-up their device to other players', trading and battling their friends through the Game Link Cable. These players' pokémon will gain more experience in battle, since most of their party pokémon are trades.

Self-Expressive players typically enjoy articulating ideas to express and create, finding loopholes in the game and showing off to other players. *Pokémon Red & Blue* offer a great amount of personalization opportunities that align to this playing style. Amongst others, players can name their pokémon differently (e.g. sparky instead of Pikachu), have rather eclectic collection of pokémon in their party, go for weird pokémon (e.g. Exeggute, Lickitung) or may prevent pokémon from evolving to keep them small and cute. These are the players that find and use glitches in the game to rapidly level their pokémon (Item Duplication Glitch), enter zone's that would normally require an item (Cycle Road Access Requirement Bypassing) find ways to distort the image of pokémon (Glitch Pokémon), etc. It is safe to assume that *Pokémon Red & Blue* has astrong appeal to Self-Expressive players.

Figure 147: The gym leaders in Pokémon illustrate (from left to right) pragmatic, theoretical, interpersonal and self-expressive players

Figure 148: Bounden

FINGLE & BOUNDEN
GameOven, 2011 & 2014

The last case discussed in this section is the design process of Game Oven's Adriaan de Jongh. Being renowned for his award winning game: *Fingle* (GameOven, 2011), de Jongh lately released the dancing game *Bounden* (Game Oven & Dutch National Ballet, 2014). De Jongh's design process appears to correspond to design from dynamics approach as suggested in section 3.6. To me, this is one of the most interesting ways to create games that feel natural though innovative to people, make them feel curious about how they can enhance the experience themselves.

From an autonomy-supportive perspective, de Jongh's games initially appear not to be very autonomy-supportive, but a closer inspection shows that the autonomy-support is found somewhere less obvious.

Fingle is a multiplayer-multi-gesture game on the iPad. Two players put their fingers on small squares on the tablet's surface. The goal of the game is to move the squares into their corresponding squares and hold them in place for several seconds. The first levels introduce players to this little game, and are rather simple. However, when target-rectangles start to move and more fingers are needed to complete the 'finger-twister-like' puzzle, the game becomes increasingly more difficult. What's more, touching other peoples' hands while playing a game feels strangely intimate.

De Jongh told me that his inspiration for *Fingle* emerged from watching players play multi-touch games on larger surface tables. These tables have a touch sensitive screen and in the game described by de Jongh, players needed to cooperate to finish a puzzle. Sometimes during play, players touched each other's hands, laughed in embarrassment and tried to avoid each other's hands afterward.

De Jongh figured that this activity, accidently touching each other's hands while watching a screen, was so intimate an experience, and therefore interesting, that he decided to develop a game in which these kinds of touch-dynamics were at the core of the experience.

In short, de Jongh analyzed playful activities that were already taking place. He chose one that elicited excitement or interesting aesthetics, and created a game that enforced these kinds of activities. I deliberately use the word 'enforcing', since the game cannot be completed without touching each other's hands. It can be argued that de Jongh's design approach originates from the experience (aesthetics) since *Fingle* is such a steering game. However, players can play it with two, three and four hands. Having introduced the game to many of my friends and colleagues, I found that players tend to play the game in different ways, depending on players' context, relations and state of mind. At first, players are obliged to follow the rules presented by the first levels. However, in later levels players start fooling around, trying to deceive the game.

In *Fingle*, external regulations are in place to explain the game's fixed mechanics and instruct players in correct performance. However, when the more intimate (and sexually suggestive) levels are played, people tend to conform more to the context of play than to the game. For example, in one level, players must move their fingers in a particular way that insinuates intercourse. The groaning and the soul music in the background, adds to this suggestion. Players familiar with one another tend to laugh out loud, but comply to the game nonetheless. Players unfamiliar (and in particular male to male players) appear embarrassed and fix the puzzle with two hands. The game system cannot recognize this 'cheat'. Instead it makes suggestions that the game is more fun played with one hand only.

Fingle is a game that facilitates social negotiation and self-expression in various ways. Although it is rather restrictive in it suggested use, the openness of the game offers various playing styles, which makes it rather autonomy-supportive.

Another game by de Jongh is *Bounden* (Game Oven & Dutch National Ballet, 2014). *Bounden* is a two player dancing game that utilizes the gyroscope of a smartphone to suggest particular moves. GameOven describes the game as follows:

> *Game Oven's whimsical dancing game for two players, with choreography by the Dutch National Ballet. Twist and twirl elegantly, or get entangled with a friend. Holding either end of a device, you tilt the device around a virtual sphere following a path of rings. You swing your arms and twist your body, and before you know it, you are already dancing.* (GameOven, 2014)
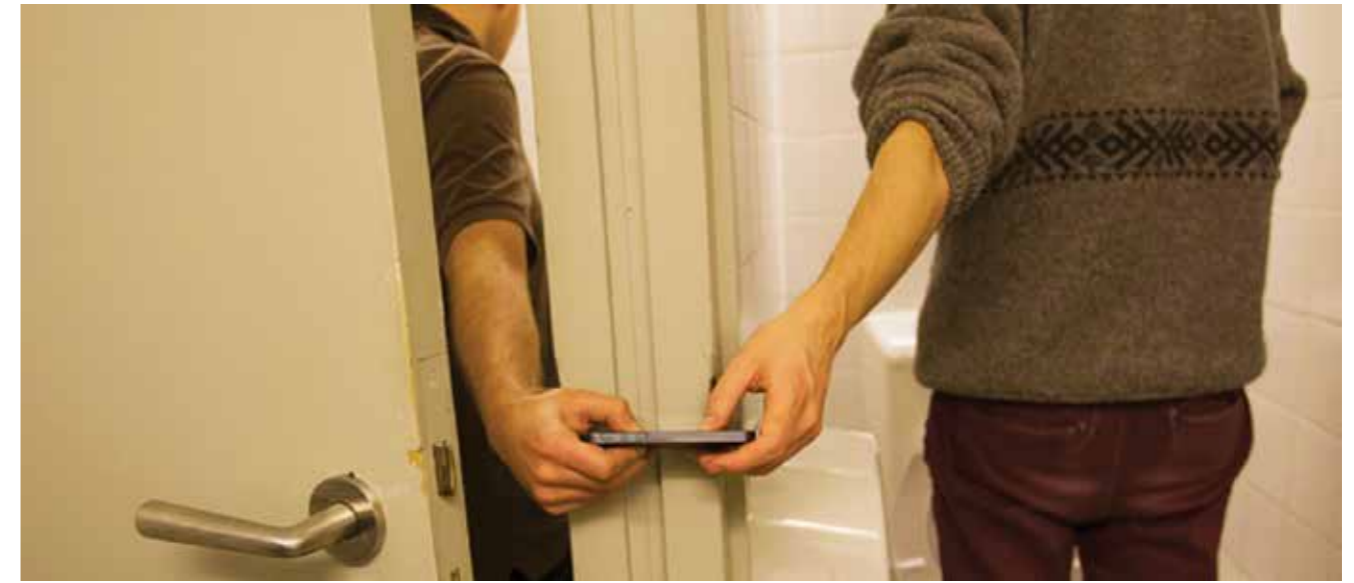
Together with the Dutch National Ballet, GameOven developed choreography in which dancers hold on to one device and dance together. The game was inspired by the playful activities witnessed in an earlier game by GameOven called *Friendstrap* (GameOven, 2013a)

> *Friendstrap is a conversation starter, the perfect ice breaker when you want to get to know someone. Two players hold a smartphone as long as possible while talking about unusual things. Go from stranger to best friends with more than 1000 conversation topics to talk about. Share your deepest secrets, your most shameful moments, your biggest fears and your fondest memories. You might get closer to your fellow player than you like!* (GameOven, 2013b)

In the game, players hold on to a phone together for as long as they can. Small vibrations suggest that players let go for a second (flex their fingers) and grab back. De Jongh and his companion Bojan Endrovski played the game for 24 hours straight. During this time and while watching other players play friendship, de Jongh noticed that players often started to swing the phone around. This automatic or natural behavior appeared rather engaging. De Jongh used this principle as one of the main dynamics in *Bounden*. Creating a game in which swinging a phone back and forth is a recurring move in the choreographed dances.

Like *Fingle*, *Bounden* only recognizes the movement of the hand. This means that players can create their own dances or weird movements. The rules and feedback in Bounden is rather forgiving. Players can (especially in the first levels) make many mistakes, exploring, experimenting and struggling with the game's mechanics and their own moves. In comparison to *Fingle*, *Bounden* is more autonomy-supportive since it offers more ways to self-express oneself through play. Although de Jongh told me that he always tries to search for ways to control players' behavior, I think that he actually facilitates movement more than he instructs or explains how to move.

It is my opinion that GameOven's most fun and innovative games come from de Jongh's keen observations of existing playful behavior and his ability to create tools for self-expression and social negotiation that facilitate this play and make it resonate in unpredicted and intimate ways.

Concluding remarks

This appendix discussed six games, which inspired most of my work. In only forty years, the game industry has made some huge leaps in innovation. It has created a better understanding of what play entails and why games can motivate players to go to extremes. If I would be asked to identify a trend growing in the industry, then it would be a trend towards increased autonomy-support. Game designers are increasingly working together with their targeted audience to create more diverse and immersive games that empower their users to create their own games.

The rise of the indie game development scene, mostly thanks to cheaper and easier game development platforms, inspire and critique an industry that is maturing. It is an industry that is becoming more inclusive to socio-cultural minorities, more able to critique societal issues, and more proficient to educate players than ever before. Within the industry, we give a greater say to the players, more and more opening up to creative qualities of emergent gameplay and autonomous acts.

The industry is still maturing, but with unbelievable speed. I think that the future will present us with new and impressive restructuring practices, which have players not only changing, manipulating or rearranging fictional and imaginary structures, but which we can play with real aspects of life, offering individuals to act more autonomously and presenting them increasingly with more agency and self-efficacy to live the life they want.

Nintendo's slogan in the 80s was: "Now you are playing with power!" The phrase connects to the technical deterministic opinion of the industrial age. Today's game industry is no longer as tech-savvy as it was twenty years ago. Designers are increasingly abdicating their authorship over the game to the players. As a result, players are not playing with power, but today's players are empowered to play.

Figure 151: Nintendo's 80s and 90s advertisement

247

References

Bjork, S., & Holopainen, J. (2004). *Patterns in Game Design.* Charles River Media.

Blizzard Entertainment. (2004). *World of Warcraft.* PC: Blizzard Entertainment.

Deen, M. (2007). Versnelde Kennisontwikkeling in Games. Utrecht University.

Douglas, A. (2012). Here Are The 10 Highest Grossing Video Games Ever. *Business Insider*. Retrieved August 5, 2014, from http://www.businessinsider.com/here-are-the-top-10-highest-grossing-video-games-of-all-time-2012-6?op=1

Game Freak. (1996). *Pokémon Red & Blue.* GameBoy: Nintendo.

Game Freak. (2013). *Pokémon X and Y.* N3DS: Nintendo.

Game Oven, & Dutch National Ballet. (2014). *Bounden.* Game Oven.

GameOven. (2011). *Fingle for iPad.* iOS: GameOven.

GameOven. (2013a). *Friendstrap.* iOS; GameOven.

GameOven. (2013b). Friendstrap. *PlayFriendsTrap*. Retrieved August 7, 2014.

GameOven. (2014). Bounden. *PlayBounden*. Retrieved August 7, 2014.

Gorges, F. (2012). *The History of Nintendo 1889-1980 SC.* Triel-sur-Seine, France; London: Les Editions Pix'N Love.

Iwabuchi, K. (2002). *Recentering Globalization: Popular Culture and Japanese Transnationalism.* Duke University Press.

Jeff, Cj. V. (1995). *GameFAQs.* CBS Interactive. Retrieved from www.gamefaqs.com

Justin.tv. (2011). Twitch.tv. *Twitch.*

Kent, S. L. (2001). *The Ultimate History of Video Games: From Pong to Pokemon--The Story Behind the Craze That Touched Our Lives and Changed the World.* Three Rivers Press.

Logg, E. (2012). *Classic Game Postmortem: Gauntlet.* Presented at the Game Developers Conference, San Francisco. Retrieved from http://www.gdcvault.com/play/1015841/Classic-Game-Postmortem

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, *5*(4), 333–369.

Nintendo. (1981). *Donkey Kong.* Arcade: Nintendo.

Nintendo EAD. (1985). *Super Mario Bros.* Nintendo Entertainment System: Nintendo.

Nintendo EAD. (1991). *The Legend of Zelda: A Link to the Past.* Super Nintendo Entertainment System: Nintendo.

Nintendo EAD. (2013). *The Legend of Zelda: A Link Between Worlds.* N3DS: Nintendo.

Nintendo EAD Tokyo. (2013). *Super Mario 3D World.* Wii U: Nintendo.

Nintendo R&D1. (1983). *Mario Bros.* Arcade: Nintendo.

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A Motivational Model of Video Game Engagement. *Review of General Psychology*, *14*(2), 154–66.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, *55*(1), 68–78.

Serebii.net. (2014). Serebii.net. Retrieved August 7, 2014.

Tobin, J. (2004). *Pikachu s Global Adventure: The Rise and Fall of Pokémon.* Durham: Duke University Press Books.

Twitch Plays Pokémon. (2014, August 5). In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Twitch_Plays_Pok%C3%A9mon&oldid=620002736

Vygotsky, L. S. (1978). *Mind in Society: Development of Higher Psychological Processes* (New edition.). Harvard University Press.

B

CV, LISTS AND DUTCH SUMMARY

CURRICULUM VITEA **MENNO DEEN**

Menno Deen was born on March 19th 1982 in Haarlem (the Netherlands) and raised in the Northern part of the Netherlands (Hoogeveen, Zwolle). In 2006, he graduated at the Utrecht School of Arts as BA in Design Technology with a game project called GaymOver Sexuality and Acceptation. This may have been the very first videogame critically reflecting on intolerance towards gays. Fascinated by the prospect of games as an expressive medium, Menno enrolled in the master program New Media and Digital Culture at the Utrecht University. Within this program he did an internship at Ranj Serious Games, and graduated with a Master thesis about the correspondence between learning styles and playing styles.

After his MA graduation, Menno worked with Ranj Serious Games as game researcher. During this time, he worked closely together with the development team, met with clients and represented the company on various events and occasions. In 2009, Menno started his PhD project on serious games at the Fontys University of Applied Sciences and Eindhoven University of Technology (TU/e). During this project, he initiated various projects, such as the annual Games [4Health] Jam and the global Games [4Diversity] Jams. He introduced the Computer Human Interaction community to gamejamming by organizing the Games [4Research] Jam workshops at CHI2013 and CHI2014. In collaboration with Rob Tieben he developed a course and jam session about games in swimming pools. Menno is currently exploring how games could contribute to cognitive therapy sessions in the Games [4Therapy] Project. At their start-up Lapp Menno works with Mark van Kuijk, exploring how games can foster child-parent interaction.

During his PhD project, Menno received various awards. Twitter Word Snake, a digitization of the popular word game received a 1st price at the Dropstuff Pleased to Meet You contest. The SwimGames project received a 2nd price for Best Learning Game at The 2014 European Serious Games Awards (GALA) and a 2nd price at the Health 2.0 Challenge 2010. STEM a game concept about the politics of voting received 2nd price at GamePrijsvraag.nl in 2010. The meat-controlled-game Heart to Get received an Honorable Mention at the Dutch Global Game Jam 2013 for its use of novel interfaces. And Vildu?!, a game about sexual boundaries, was approved 2nd by the audience during LystSummit 2014. Also, the paper The Differences Between Problem-Based and Drill & Practice Games on Motivations to Learn that he wrote in collaboration with his PhD supervisor Prof Dr. Ben Schouten, was selected as Meaningful Play 2014 Top Paper.

Figure 152: Menno Deen

253

LIST OF **PUBLICATIONS**

Chatham, A., Schouten, B. A. M., Toprak, C., Mueller, F., Deen, M., Bernhaupt, R., … Pijnappel, S. (2013). Game jam. In CHI '13 Extended Abstracts on Human Factors in Computing Systems (pp. 3175–3178). New York.

Deen, M. (2009). Onderzoeksrapport validatie CheckOut! Ranj Serious Games & ROC West-Brabant.

Deen, M., Heynen, E. J. E., Schouten, B. A. M., van der Helm, G. H. P., & Korebrits, A. M. (2014). Games [4Therapy] Project: Let's talk! Presented at the Games for Health Europe, Utrecht.

Deen, M., Cercos, R., Chatman, A., Naseem, A., Bernhaupt, R., Fowler, A., … Mueller, F. (2014). Game jam: [4 research] (pp. 25–28). ACM Press.

Deen, M., & Korsman, N. (2010). Casual Games. In J. de Haan & R. Pijpers (Eds.), Contact! Kinderen en Nieuwe Media. Houten: Bohn Stafleu van Loghum.

Deen, M., & Schouten, B. A. M. (2014). The differences between Problem- Based and Drill & Practice games on motivations to learn. Presented at Meaningful Play Conference, East Lansing.

Deen, M., & Schouten, B. A. M. (2010). Let's Start Playing Games! how games can become more about playing and less about complying. Presented at the Fun & Games, Leuven.

Deen, M., & Schouten, B. A. M. (2011). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. In F. Patrick (Ed.), Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches. IGI Global.

Deen, M., Schouten, B., & Bekker, M. M. (2015). Playful Identity. In J. Reasens (Ed.), Playful identities: The ludification of digital media cultures. Utrecht University.

LIST OF **PRESENTATIONS**

Deen, M. (2009). Leren met Games. Presented at the Generatie Einstein en het onderwijs, Wezep.

Deen, M. (2009). Embargo: Game voor Nederlandse Taalontwikkeling. Presented at the Studiedag ROC, Breda.

Deen, M. (2010). Stem: Een spel over stemmen. Presented at the Games Prijs Vraag: Ministerie van Binnenlandse Zaken en Koninglijke Relaties, Den Haag.

Deen, M. (2010). Social Gaming. Presented at the Netwerkdag Mediawijsheid: Pecha Kucha, Hilversum.

Deen, M. (2010). Motivaties voor Spelen & Leren. Presented at the IT's Time, Eindhoven.

Deen, M. (2010). Games that Motivate to Learn: Designing Serious Games by Identified Regulations. Presented at the DiGRA, Utrecht.

Deen, M. (2012). [Inter]Active Swimming: digital games in the swimming pool. Presented at the Games for Health Europe, Amsterdam.

Deen, M. (2012). Workshop Game Design: Core Concept. Presented at the Game in the City - Masterclass, Amersfoort.

Deen, M. (2013). Crossing Boundaries: Game User Research in the Swimming Pool. Presented at the Festival of Games, Amsterdam.

Deen, M. (2014). Video gaming in the pool. Presented at the w00t Festival, Copenhagen.

Deen, M. (2014). Why the Games [4Diversity] Jam Mattered Matters. Presented at the Lyst Summit, Coenhagen.

Deen, M. (2014). Games [4...] Jams: Lessons Learned over 5 years of Serious Jamming. Presented at the Serious Play Conference, Los Angeles.

Deen, M., & Tieben, R. (2011). Games [4Health] Jam Presentation. Presented at the Games for Health Europe, Amsterdam.

Deen, M., & Tieben, R. (2013). Game User Research in Challenging Contexts: SwimGames. nl. Presented at the GUR-Summit, San Francisco.

Sturm, J., Tieben, R., Deen, M., & Schouten, B. A. M. (2011). PlayFit: Designing playful activity interventions for teenagers. Presented at the DiGRA 2011 - Think Design Play, Hilversum.

Tieben, R., Deen, M., & Sturm, J. (2011). PlayFit – how to activate teenagers. Presented at the Games for Health Europe, Amsterdam.

LIST OF **GAMES DESIGNED**

Deen, M., & Tieben, R. (2011-2013). 30+ SwimGames

Deen, M., Tieben, R., Sleegers, T., Oonk, J., & van Kuijk, M. (2013). Twitter Word Snake.

Deen, M., YipYip (2014) Vil Du? A game about sexual boundaries.

Deen, M., Kuijk M. (inDev), Rups.

Deen, M., Kuijk M. (inDev), Mirror Star

Deen, M., Tieben, R., Waarbroek, L., Oonk, J., Leeuwe, M., & van Kuijk, M. (2013). Heart to Get. PC: Global Game Jam.

Deen, M., & Verhoeven, B. (2011). Combinatorics. PC: Fontys University of Applied Sciences.

LIST OF **EVENTS & WORKSHOPS ORGANIZED**

Deen, M., Tieben, R., Schouten, B. A. M., Reassens, J., Bekker, M. M. (Tilde), & Lammes, S. (2011, September 15). PhD Workshop on Investigating Games and Play: Themes, Theories, Practices, Methologies. Presented at the DiGRA 2011 - Think Design Play, Hilversum.

Games [4Health] Jam'10: Revalidation

Games [4Health] Jam'11: Prevention

Games [4Health] Jam'12: Public Play

Games [4Health] Jam'13: Sink / Swim!

Games [4Health] Jam'14: It's Mental!

Games [4Diversity] Jam 2014 EU: LGBTQ + Feminine

Games [4Diversity] Jam 2014 USA: LGBTQ + Feminine

Games [4Design] Jam CHI '13: Inspire

GameJam [4Research] CHI'14

LIST OF **FIGURES**

DUTCH SUMMARY

Dit proefschrift brengt verschillende wetenschappelijke disciplines bij elkaar, die tot nu toe voornamelijk los van elkaar bestudeerd zijn. Stapsgewijs worden de disciplines, educatie, game design en psychologie samengebracht in een ontwerpmodel voor educatieve games, met als doel: een positieve bijdrage te leveren aan de motivatie van studenten om te leren. Twee termen voeren de boventoon in dit ontwerpmodel. De termen: Herstructureren en autonomie-ondersteunend functioneren als sleutelwoorden om de bovenstaande disciplines te verbinden.

De term herstructureren kan gezien worden als belangrijkste bijdrage van dit proefschrift. Het beschrijft een nieuwe manier om spel en spelen te benaderen. Daar academici en ontwerpers spel voornamelijk karakteriseren bij de limitatie van de regels en de rijkheid van ervaringen, richt dit perspectief zich op spel als een activiteit. Het definieert de activiteit van spelen als een herstructureringsactiviteit en probeert hiermee inzicht te geven in de daadwerkelijke handelingen die plaats vinden als men speelt. De reden hiervoor wordt met name gevoed door het tweede sleutelterm: autonomie-ondersteuning.

De ondersteuning van autonoom (spel)gedrag beschrijft een trend in de game industrie, onderwijs en psychologie, waarin het individu in toenemende mate zeggenschap krijgt over haar eigen handelen. Zo kunnen spelers in videogames op steeds meer verschillende manieren het spel spelen, worden studenten in onderwijs steeds verantwoordelijker gemaakt voor hun eigen ontwikkeling en suggereert een cognitief psychologische stroming dat het 'autonome gevoel', één van de meest motiverende ervaringen is.

De ontwerprichtlijnen in dit proefschrift schrijven een ontwerpproces voor waarin de zoektocht naar de herstructureerbare elementen van de lesstof en de vertaling van deze elementen naar spelelementen een bijdrage kunnen leveren aan de ontwikkeling van autonomie-ondersteunende games voor het onderwijs. Hetgeen op haar beurt een bijdrage kan leveren aan motivatie van studenten om te leren.

De onderzoeksvraag van deze thesis luidt daarom:

> *Wat voor ontwerprichtlijnen stimuleren de ontwikkeling van games voor autonoom spel- en leergedrag, en welke bijdrage leveren dergelijke games aan de motivatie van studenten om te leren?*

Het proefschrift is opgedeeld in twee stukken. Het eerste gedeelte buigt zich over ontwerprichtlijnen om autonoom spel- en leergedrag te stimuleren. Hiervoor wordt eerst een theoretisch raamwerk geformuleerd vanuit de ontwikkelingspsychologie en game design theorie. Deze richt zich met name op de integratie van de lesstof in de gameplay, en de stimulering van autonoom spelgedrag. Vanuit de theorie worden ontwerprichtlijnen geformuleerd. Deze worden getoetst met de ontwikkeling van een game voor wiskunde onderwijs: *Combinatorics.*

Het tweede gedeelte van het proefschrift richt zich op motivatie. Er wordt eerst een theoretische verhandeling gehouden over motivatie, alvorens de ontwerprichtlijnen worden geformuleerd. Deze richtlijnen worden eveneens geïllustreerd met ontwikkeling van *Combinatorics.* De hypothese dat autonomie-ondersteunende games een bijdrage kunnen leveren aan de motivatie voor leren, wordt vervolgens gevalideerd. Aan het eind worden ontwerprichtlijnen gepositioneerd ten aanzien van andere ontwerpmethodes en worden de voornaamste bijdrages van dit proefschrift nader besproken. Hieronder volgt een uitgebreidere samenvatting van het proefschrift.

Na de introductie beschrijft sectie 2 verschillende ontwikkelingen binnen educatie en ontwikkelingspsychologie. Het wordt duidelijk dat er in het hedendaags onderwijs een verschuiving waarneembaar is waarin de nadruk van 'traditionele' waarden (e.g. de memorisatie van feitenkennis en de ontwikkeling van zeer specifieke vaardigheden) wordt verlegd naar de ontwikkeling van meta-cognitieve vaardigheden (e.g. probleemoplossend vermogen, empathie, leer-strategieën). Daarnaast worden studenten in toenemende mate verantwoordelijk gesteld voor hun eigen ontwikkeling. Onderwijzers kunnen hier een bijdrage aan leveren door autonoom leergedrag te ondersteunen. Dit betekend dat studenten de mogelijkheid krijgen om binnen de kaders van het onderwijs te experimenteren en te worstelen met de leerstof om zélf de betekenis en leerwaarde van de stof te doorgronden. Dergelijk autonoom leergedrag kent overeenkomsten met (autonoom) spelgedrag.

Sectie 3 legt de overeenkomst tussen autonoom leergedrag en spelgedrag nader uit. De sectie beschrijft een vergelijkbare ontwikkeling in de game industrie. In toenemende mate zijn spelers in staat om zelf een oplossing te vinden voor een probleem, om op hun eigen manier te spelen en om zichzelf te uiten in games. In andere woorden, games stimuleren in toenemende mate autonoom spelgedrag. Om dit spelgedrag beter te duiden, introduceert sectie 3 de term: herstructureren. Met herstructureren wordt de herschikking, verandering en/of manipulatie van een bestaande configuratie bedoeld. Aangezien de bestaande configuratie wordt veranderd, leidt herstructureren altijd tot 'iets nieuws'. Dit proefschrift suggereert dat spel, bij definitie, altijd gaat over herstructureren.

Het karakteriseren van spelen als een herstructureringsactiviteit, kan een bijdrage leveren aan het ontwerp van spelomgevingen die autonoom spelgedrag stimuleren. Dit komt, omdat de karakterisering een focus legt op spelen als activiteit, en minder op limiterende regels of afgedwongen ervaringen.

Sectie 3 suggereert dat ontwerpers een spel kunnen ontwerpen door te starten met de gewenste activiteit. Vervolgens kunnen ze kijken welke minimale regelset dergelijk spelgedrag faciliteert. Door te beginnen met de handeling is het wellicht gemakkelijker om autonoom spelgedrag te ontwerpen.

Sectie 4 brengt de voorgaande sectie over educatie en gamedesign samen. Het stelt dat leren, net als spelen, een als herstructureringsactiviteit beschouwd kan worden. Studenten herstructureren immers bestaande kennisactoren en kennisnetwerken wanneer ze leren. Door deze herstructurering worden nieuwe relaties en nieuwe netwerken gecreëerd. Het herstructureren leidt zodoende tot kennisconstructie. Dit inzicht vraagt game ontwerpers om de herstructureerbare elementen van de lesstof te zoeken. Wanner deze herstructureerbare leerelementen zijn gedefinieerd, kunnen ze bijna één-op-één worden vertaald naar spelelementen.

Sectie 5 beschrijft in 10 stappen hoe ontwerpers een autonoom spel kunnen ontwikkelen voor onderwijs. Het beschrijft eerst hoe ontwerpers de herstructureerbare elementen van lesstof kunnen vinden. Vervolgens wordt de vertaling van leerelementen naar spelelementen besproken. Deze leiden tot de ontwikkeling van een prototype. Het prototype kan getest worden met gebruikers om vervolgens verder ontwikkeld te worden volgens de laatste stappen van de ontwerprichtlijnen.

De ontwerprichtlijnen van sectie 5 worden in sectie 6 geïllustreerd met de ontwikkeling van Combinatorics. Deze wiskundegame over permutaties, wordt in het proefschrift als terugkerende casus gebruikt om verworven inzichten te contextualiseren en te illustreren. De stappen uit sectie 5 en 6 worden samengevat in een abstracter ontwerp model in sectie 7. Dit model wordt het Applied Game Design Model genoemd en kan door haar abstractie ook voor andere doeleinden en contexten worden gebruikt.

Nu het duidelijk is hoe gamedesigners de lesstof kunnen integreren met de gameplay, onderzoekt sectie 8 verschillen theorieën over menselijke motivatie. Onderzocht wordt welke theorie het best past bij autonoom spel- en leergedrag. Een theorie die sterk de nadruk legt op autonoom gedrag is zelfdeterminatietheorie. Deze cognitief psychologische theorie komt in deze sectie uitvoerig aanbod. The theorie stelt dat mensen sterk gemotiveerd kunnen worden als zij zich competent (ik kan het) autonoom (ik doe het en ik doe het op mijn eigen manier) en verwant (ik doe het met mensen die van betekenis zijn) voelen ten aanzien van de te verrichte handeling. De sectie stelt enkele richtlijnen voor om aan deze behoeftebevrediging tegemoet te komen.

Naast bovenstaande behoefte bevrediging, brengt zelfdeterminatietheorie tevens verschillende regulatietypes naar voren. Deze kunnen worden gebruikt als praktisch ontwerpgereedschap. De types beschrijven vanuit welke ervaring mensen handelen. Sommigen studenten leren bijvoorbeeld omdat het moet. Deze studenten leren voor een extern doel / reden. Dit wordt externe regulatie genoemd. Andere studenten leren omdat ze daarmee een bepaald doel kunnen bereiken. Deze studenten begrijpen hoe de leerhandeling in dienst staat van hun doel. Dit wordt geïdentificeerde regulatie genoemd.

Gameontwerpers maken impliciet gebruik van regulatievormen wanneer ze een spel uitleggen aan spelers en / of wanneer ze spelers uitnodigen om verder te spelen. Sectie 8 maakt de regulatievormen en hun weerslag in gameontwerp expliciet. Tevens plaatst het de regulaties in relatie tot autonoom spelgedrag. Het wordt duidelijk wanneer bepaalde regulatievormen het gewenste effect stimuleren.

Het theoretisch raamwerk uit sectie 8 wordt in sectie 9 vertaald tot additionele ontwerprichtlijnen voor het versterken van de motivationele impact van een game. Deze richtlijnen worden direct geïllustreerd met de ontwikkeling van *Combinatorics*. Hierdoor beschrijven sectie 6 en sectie 9, tezamen, de volledige ontwikkeling van de wiskunde game. De andere secties borgen de theoretische onderbouwing van de gemaakte ontwerpkeuzes.

Of *Combinatorics* een positieve bijdrage levert aan de motivatie van studenten om leren, wordt gevalideerd in sectie 11. Hierin worden de bevindingen van een validatie studie naar *Combinatorics* besproken. De studie vergelijkt twee modi van *Combinatorics*. Namelijk een autonome versie (experiment groep) en een sturende versie (controle groep) van het spel. De studie onderzoekt derhalve twee verschillende leermethoden in hetzelfde spel. Het blijkt dat de modi allebei een positief effect hebben op motivatie van studenten. Echter de verandering in ervaren regulatie ten aanzien van wiskunde onderwijs blijkt voor controle en experiment groep te verschillen. Dit roept nieuwe vragen op aangaande de implementatie van games in het onderwijs.

Deze vragen worden in sectie 12 nader besproken, evenals de belangrijkste bijdrage die het proefschrift levert aan academisch onderzoek en gameontwikkeling. Deze bijdrages worden gepositioneerd ten aanzien van andere ontwerpmethodes en ontwikkelingen in de industrie. Hiermee wordt het onderzoek nader gecontextualiseerd en wordt er een voorstel voor toekomstig onderzoek geformuleerd. Hiermee wordt een voorzet gemaakt voor de eind conclusie in sectie 13.

Samenvattend, het proefschrift beschrijft een ontwerpmethode voor educatieve games die het autonome leergedrag van studenten stimuleert. Hiermee wordt getracht een positieve bijdrage leveren aan de motivatie van studenten ten aanzien van leren. Het zoeken naar de herstructureerbare elementen in de lesstof en de vertaling van deze elementen naar een game, vormen de voornaamste bijdrage van het proefschrift ten aanzien van bestaande ontwerpmethodes. De focus op autonomie-ondersteuning komt overeen met trends in onderwijs en gamedesign, en zou een bijdrage kunnen leveren aan de motivatie van studenten om te leren.