

Concept Model for designing engaging and motivating games for learning

The Smiley-model

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### **Abstract**

The desire to use learning games in education is increasing, but the development of games for learning is still a growing field. Research shows that it remains difficult to develop learning games that are both instructive and engaging, although it is precisely the presence of these two elements that is believed to be an advantage when using learning games in education. In this paper the Smiley-model is presented (figure 1). The model describes which parameters and elements are important when designing a learning game. The present research is a result of a case-based action research study for designing a music learning game that teaches children to play piano using sheet music, and at the same time is fun and engaging. Although the model was originally developed for and through music, it has a more generic nature, and may be relevant for other fields as well. The Smiley-model is a condensed version of a design manual developed in a Master's thesis (Weitze, 2011), created on the basis of theoretical and empirical analysis, and is currently being applied to other research projects. The research concerning design for learning was carried out with an analysis of specific and general learning theory. Furthermore, theories about children, culture and media, as well as empirical analysis of the writers' own music-teaching practice were investigated. Motivation and engagement in music learning games was investigated through: 1) an analysis of various theoretical and empirical approaches to implementing learning in a learning game, 2) study of motivational theories, 3) analysis of theory of play and existing experiences on dissemination of learning in games in fun ways 4) analysis of motivating and engaging game elements, and 5) analysis of similar music learning games. During an iterative design process, the design manual was used for development of various prototypes of the learning game concept. This happened through action research in collaboration with the users, in participatory design workshops, combined with observation, qualitative

interviews, and peer reviews. Through empirical studies and design development, it was possible to add new aspects to the design manual, resulting in the Smiley-model. The Smiley-model is now proving useful as a combination of a heuristic and an inspirational tool (more flexible and contextual than static), when designing engaging learning games, and gamified learning environments.

**Keywords:** serious game design model, learning design in games, design of engaging learning games, fun in games, music learning games, action research, design process, participatory design.

### Parameters in a motivating and engaging game for learning

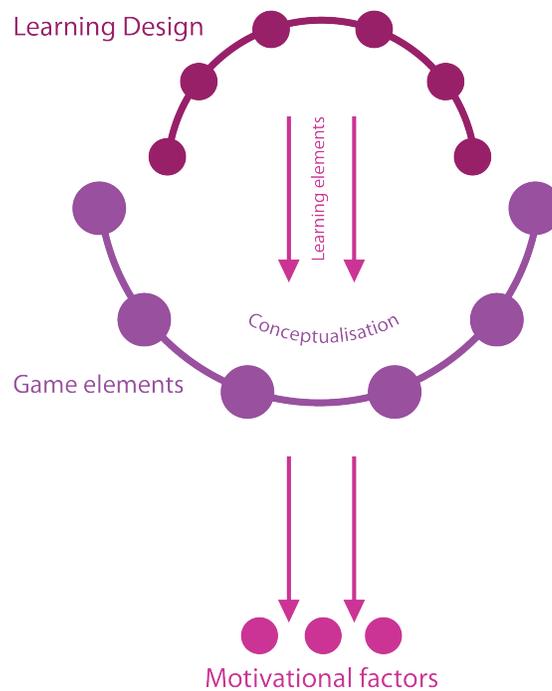


Figure 1: The Smiley-model

## Introduction

With today's increased use of media among children and young people, and with the possibility for the individualization of learning this provides (Shell, 2012), it is only natural to use this opportunity within the field of learning to design educational games for children. James Paul Gee is one of the leading persons in the debate on "Serious Games". He believes that part of future learning will take place through good computer games containing elements that engage, call for reflection and creativity, and provide feedback. These games may be designed for the individual level and learning style, providing challenges and opportunities for repetition of relevant topics, and also allowing for social interaction, and distribution of knowledge (Gee, 2007). A broad research field within the *Games for learning field* continues to share and explore this with various participants such as the gaming industry, researchers in the designs for learning field, and subject teachers. The idea to combine gaming and learning has particularly been based on two main arguments. Firstly, one would like to make learning fun, using motivational aspects of playing games. Secondly, it is believed that learning something by doing it in a game, "learning by doing", is a powerful learning method (Kirriemuir & McFarlane, 2006). Whether these two arguments are valid depends on how one chooses to implement learning and motivation in the games.

The field of learning games is so new that there is still much to be learned before there can be general guidelines that provide an understanding of the parameters, crucial for achieving good learning through games (Winn, 2007). It is indeed difficult to design a learning game that is both engaging and educational (Flanagan et al, 2010). We need to understand what effect and impact learning games have both in themselves and compared to other types of learning. We also need to develop an understanding for the transfer effect that the various concepts of teaching,

learning, interface, etc. has on the individual student (Wilms & Mogensen, 2011). It is important to discover the potential and diversity of learning games before they can have a meaningful role in both formal learning and in informal learning (when we learn whilst in the process of doing something else) (Kirriemuir & McFarlane, 2006). As a conclusion on a study of serious games, including learning games, Ratan and Ritterfeld (2009) recommend that in order for the integration between games and learning to succeed, it requires: "... *parallel experiences* [between games and learning] *and is best realized in game simulation that invites exploration and requires complex reasoning, [...] applying these learning principles to many areas of academic education would significantly enrich the quality and effectiveness of serious games.*" (Ratan & Ritterfeld, 2009, p. 20). Exploration and reflection sound like good principles to include in a learning game, but it still leaves the questions: Can the player acquire the intended knowledge? Can this happen in a way that may be targeted to a specific content area? And is it possible to maintain the motivational aspects of the game? Consequently, we find that the study of potentials and effects of learning games and of the conceptualization of adequate models and guidelines should be developed in parallel with the experimentation with developing games. This calls for an iterative approach between theory and practice, and between design and evaluation. In this paper we present both the theoretical construct and the empirical data, which are iterative and parallel developed into the smiley model (figure 1).

In learning to play the piano, it may be difficult for children to have the patience needed to acquire the technical skills that it takes to play an instrument. However, maybe one can use new technology to facilitate a part of the learning? With this perspective in mind, it becomes interesting to examine whether you can implement piano instructions in a learning game, and what benefits, complications, and transfer opportunities this would give the student/player. When

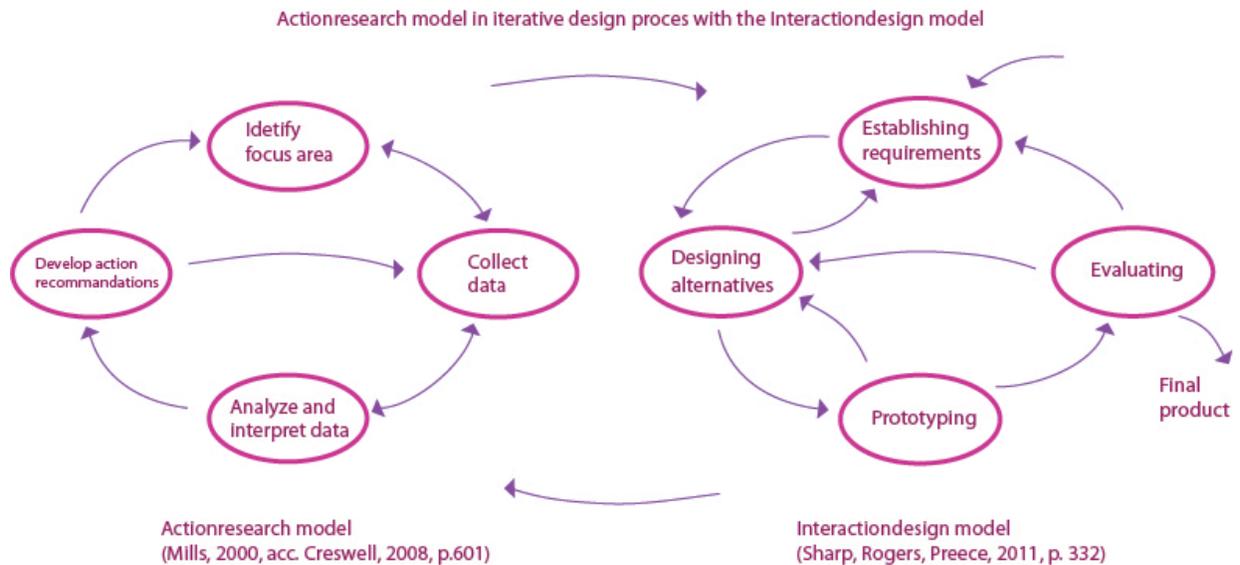
a child is taught how to play the piano, it includes the instruction in, and training of music theoretical concepts, which is time consuming and removes the focus from the essence of the education: the fun and engaging part of playing music. It is relevant to explore how the time consuming memorization in music education could be designed, so it becomes a fun and engaging music learning game on the computer, that allows for the learning of musical concepts through play/games. Thus, the main research question addressed here is this: *"Which parameters and elements are important when designing a fun and engaging music learning game for 6-9 year olds, that teaches children to play piano by notes?"* Through the iterative approach between theory and practice, and between design and evaluation, the Smiley-model was derived.

**Structure of paper:** The investigation of theory and practice took place in parallel. However, for structural reasons, this paper presents the theoretical development of the Smiley-model in part one, and continue in part two with the case of learning sheet music at the piano.

### **Research Design**

To work with the research question on a theoretical, methodological, and practical level means identifying, investigating and experimenting with elements of learning, fun and engagement / motivation. We argued for a dual approach, which was respectively analytical and exploratory (figure 2). In the analytical part, a number of theoretical and empirical analyses were carried out, concerning designs for learning, learning theory, educational games, motivation, and engagement in games. The exploratory part of the study was used to deepen the problem area to develop ideas and action guidelines /theories through the concept development in collaboration with different groups of users (children, parents and teachers). The project had a problem-oriented approach, and was carried out in practice, in order to develop ideas and action guidelines /theories to change practice (Peters & Robinson, 1984). The design development was

carried out with action research methodology as a framework (Creswell 2008) together with the iterative interaction design model.



**Figure 2: Action research and interaction design models in iterative design process**

The two methods have informed each other at the point where themes / theories from the analysis have moved from being a research based theory, to being an idea in the concept development; then the concept/ prototype was tested and further developed in collaboration with the users. The data from these empirical investigations was analyzed and interpreted based on the concept, providing theoretical findings. These theoretical contributions based on practice were then handed over to the theoretical concept development (hereby returning to the action research model). By choosing action research as a framework for addressing the research question, an opportunity is given to combine a theoretical approach, following a hermeneutic model that involves iterative analysis and discussion of the problem area (Nielsen & Nielsen, 2010), with development in practice in collaboration with the audience. At the same time, the method allows for a direction that has more focus on the user experience as a quality test on the product, rather than a focus on the product itself. The operationalization of the concepts from the research

question is therefore conducted both through the theoretical and empirical analyses, through the concept development, and through qualitative empirical approaches (such as: practices in piano teaching, participatory design, future workshop, qualitative interviews, observation, sketching etc.). The lead author's background as an educated pianist and piano teacher also contributed to the concept development.

## **PART 1: THE THEORETICAL DEVELOPMENT OF THE SMILEY MODEL**

### **Learning and Fun – a dichotomy or possibility**

This research attempts to find a solution for the dilemma that can occur in between the learning design, and the game design in the development of a gameplay, when you want to design a game that has a formal learning goal, and at the same time should be fun and engaging to play for the child. These difficulties can be seen as a dilemma that arises from two professional positions: the game designer's and the subject specialist's different approaches towards a learning game (Iuppa and Borst, 2010). How can you develop a game that is both instructive and motivating? Should emphasis be placed on the learning, or should it primarily be motivating and engaging? Ideally, learning should take place in a motivating game.

The achievable balance between the learning and the fun in the game will also to a great extent depend on, *what* you want the child to learn. Is it the study of musical notes or, for example an exploratory and analytical knowledge acquisition about how to compose a piece of music? You have to assess which learning strategies are appropriate to use in the dissemination of musical knowledge, when children are getting to know the musical language. The different learning strategies will require different game mechanics in the game. In addition, you must

know the basics of the piano teaching practices when selecting the strategy on how learning is implemented in the game.

In the current context, a fun learning game is defined as: *a learning game that will motivate and engage the player*. Therefore, the objective becomes to explore motivation and engagement in relation to games, and through analysis and observation to assess which parameters and elements are perceived as fun for the children, and whether this can be combined with learning music.

### Design for learning

When investigating learning perspectives for learning materials, as a game, it makes sense to begin by going into the practical level - the learning design or didactic design. (In a Scandinavian tradition, didactic is used as a term covering: to plan, to carry-out, and to evaluate teaching processes, no matter which learning paradigm is applied, whether instructional or constructionist collaborative). Learning theorists' Hiim and Hippe's (1997) didactic frame model describes six important points to consider when planning and carrying out teaching (figure 3). The aim was thus to start with the identification of the student's prerequisites for learning, the setting of the teaching, the learning goals, the educational content, and the need for evaluation of learning, as illustrated in the upper part of the Smiley Model. The investigation in practice did not have a clear subdivision corresponding to the six areas, but rather an unfolding of the relevant subjects which led to a clarification of the questions.



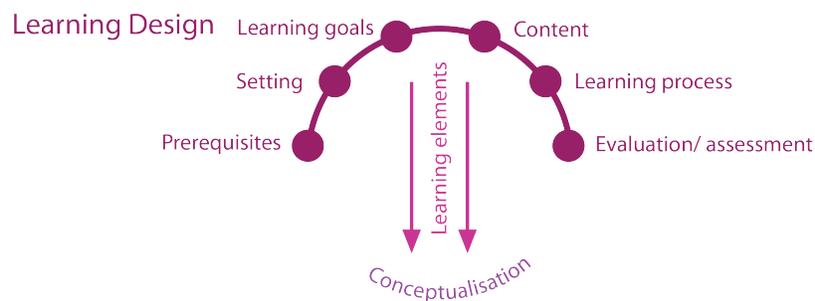
Figure 3: Frame for Design for Learning by Hiim and Hippe (1997)

To examine the student's *prerequisites for learning* and the *setting* of the teaching, the target group's life-world, competencies and needs were investigated. This was done through an analysis of the relationship between children, culture and media, using the pedagogical researcher Thomas Ziehe's (Ziehe acc. Wiborg, 2009) and Marc Prensky's (Prensky, 2001) considerations about how a shift has occurred in children and young people's knowledge, behavior, and motivation. The analysis showed that in order to satisfy the target audience, you should start from the children's own life-world (Giddens, 1991), help them to set goals for their own learning (Zimmerman, 2002) and try to meet them at the digital platforms where they "reside" (Fredsbj, 2010). The target group's cognitive skills (children six to nine years old) varies within a relatively wide field (Piaget acc. to Hermansen, 2005). To meet everyone in the age group, the music learning game must be designed with the objective that the youngest can play the game at a level that does not require the child to reason to the next step based on abstract concepts, but leads him through the game with elements that seem logical in relation to his own life-world. That way, children can learn skills at the age of six and sometimes even younger (Knudsen, 2010).

To investigate the *learning process* in the game, an analysis of general and specific learning theories in relation to music education was conducted. This research showed, that we need to organize teaching through scaffolding in relation to the students' zone of proximal development (Santrock, 2006), and divide instruction into meaningful units for the beginner (Dreyfuss, 2001). It is relevant to examine the learning process through learning theories (Illeris, 2007), concerning the following three dimensions: the inner psychological process of acquisition, the interpersonal interaction level, and a willingness and desire to deal with *what should be learned*.

In the process of designing the learning process, you must also pay attention to the choice of a learning paradigm, and pedagogical design, according to *what* should be learned (Illeris, 2007; Mark Prensky acc. Kirriemuir & McFarlane, 2006). When learning to play an instrument, the type of learning will often be a mediation of tacit knowledge through skill learning by training of auditory, kinesthetic and tactile psychomotor skills (Hanken & Johansen, 1998; Nielsen & Kvale, 1999). This corresponds to the experience from practice of teaching a young child to play the piano which includes: demonstration, observation, imitation, instruction and physical guidance. This also covers the opportunity for repeated and varied practicing with feedback, as well as the opportunity to practice physically on an instrument. Other areas of music education, such as ensemble playing, could benefit to a great extent from the learning and knowledge exchange that can occur within a community, similar to Papert's argument, that knowledge is found among the participants in their practices, in their objectification through artifacts (Papert acc. Falbel, 1993), and in tools and languages where they are negotiated through a meaningful, creative processes (Gynther, 2005).

When the six learning design elements are pinpointed and identified, they then constitute the backdrop from which the learning elements will be designed and implemented in to the game (figure 4).



**Figure 4: Choosing a learning element from the backdrop of the Learning Design**

### **Implementing learning into games**

The research study went on to investigate different theories on how to implement learning into games. Many have contributed to this topic, with focus on e.g.: which learning types the various kinds of games and learning environments support (Egenfeldt, 2007); the learning possibilities the computer gives as a media (Dalsgaard, 2007); the motivating and engaging elements of traditional computer games as in the 6 "I" model (Annetta, 2010). The practical implementation of learning in to the music game was inspired by a number of these models (Weitze, 2011).

### **Fun in games**

It is important to be aware of the phenomenon *play* when developing a learning game that tries to balance between gaming and learning. Play has a potential in relation to learning, and in relation to the creation of meaningful play. However, it is not obvious that learning and fun are linked into play. Kids can find learning games boring when they do not generate the expected "playing state" as in traditional games. Therefore, you can consider creating a different expectation for the learning game genre (Jessen, 2008). There is potential for a fun learning game if the content is relevant, appropriate, and gives a sense of self-development - then children often will enjoy learning (Kirriemuir & McFarlane, 2006). You can work with the student's curiosity as a motivation for learning, by allowing the tasks to add new and thought-provoking knowledge to the learner's existing knowledge, and by creating variations in the tasks (Gärdenfors, 2010; Illeris, 2007; Vejleskov, 2009). Learning should be communicated and implemented carefully in learning games in order to make the games fun. The motivating and engaging elements of learning games occur along with the player's possibility to come to master something, comprehend something, solve tasks, and thereby *learning is the fun in games* and a

central contributor to intrinsic motivation (Koster, 2005). Motivational elements can be challenging and thought-provoking, but also difficult and cumbersome. It is important to work passionately towards making the learning game fun, and taking the concept of fun seriously - regarding it as a central design value (Flanagan et al, 2010).

### **Motivation**

An aspect of understanding ways to motivate people is to examine the reasons we may have when we wish to achieve a goal. What is the motivation behind the goal - what can basically create motivation in humans?

For a game to be really successful, the game designer works to create a game that facilitates the player's intrinsic motivation. In learning games, the literature talks about motivation to play, and motivation to learn (Sanchez et al., 2010). The following three motives are the driving forces behind the motivation to learn, and they cover the basic psychological needs: 1) *Curiosity*: to explore and imitate things, and a freedom to choose which things you want to explore (emotion: playful mood). 2) *Competence*: to show that you are an independent individual who can control and master the situation, take the initiatives and develop solutions (emotion: joy and pride). 3) *Reciprocity*: to make a difference and be an indispensable part of the community, while you achieve goals together with others (emotion: positive feeling of belonging to the community) (figure 5). If the game is designed for the player to obtain the three motives, it will help the player to feel an inner motivation to play the game (Bruner acc. Gärdenfors, 2010). "Self-Determination Theory" (SDT) is very close to Bruner's three main motivations, since the theory argues that in order to achieve inner motivation you should be reinforced in autonomy, competence, and cohesion, and that these are vital to cover the essential psychological needs

(Deci & Ryan, 2000). Next we will examine which game elements that were traditionally used in games to foster engagement and motivation.



Figure 5: Bruner's Motivational factors

### Game elements

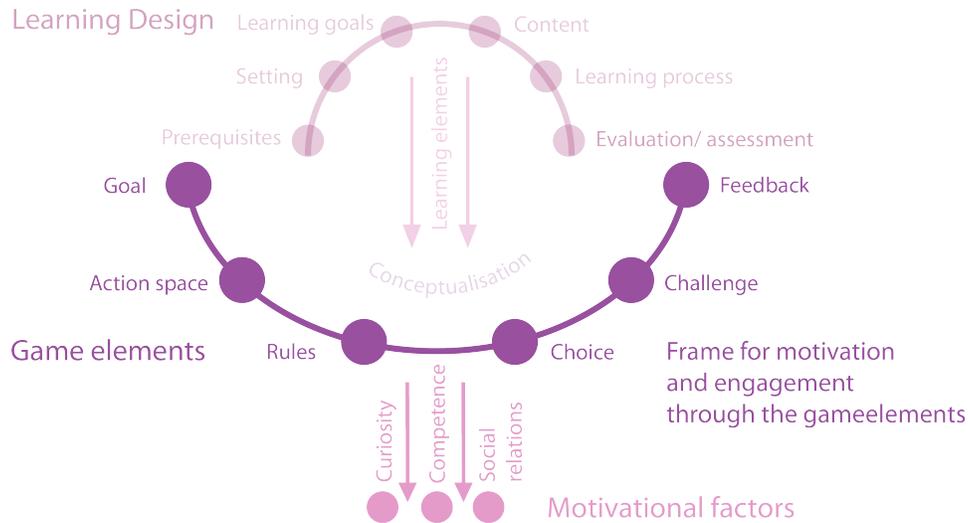
There are many definitions of games and suggestions for the appropriate elements in games, and many of them are characterized by being descriptions of specific genres of games. This research place itself on particular two definitions.

**1<sup>st</sup> Definition of important game elements in a motivating game:** Sebastian Deterding, researcher in gamification (Khaled & Deterding, 2001) describes games as, what he calls, a "well-formed human activity". His definition has been chosen to describe what is motivating and engaging in a game, because it contains many of the essential elements which, also according to other designers, are important in an engaging game. In Deterding's description, the game elements are seen from the user's perspective, and it also describes the logical structure between the game elements. Thus, the game elements and users play experience becomes closely tied together. *"We enjoy situations with clear, structured, unconflicting goals, clear limited action spaces with choice, clear and fair rules, scaffolded challenges and complexity matched to our abilities, and clear, actionable short and long-term feedback."*(Deterding, 2011).

This description agrees well with the experienced game designer Raph Koster's recommendations, which is the second definition this research is based on.

**2<sup>nd</sup> Definition of important game elements in a motivating game:** Koster presents a number of game elements on a more specific level: a) Before you start, you must make some choices that have consequences for what happens later in the game. b) You need to have a feel of action space in the game. c) There must be a solid "core mechanics", an interesting set of rules that the content can be filled into. d) There must be a range of graded challenges of increasing complexity e) Those must be solved by using tools, which can be used to do different things, each revealed gradually. f) In order to overcome them, it requires the player to have a set of skills that enables him to make choices and carry out actions, with either good or not so good consequences. These skills may, for example, be resource management, good timing, manual dexterity or overview of all variables. g) To make it a learning experience, it also requires that you have a variable feedback system, h) where a better effort by the player should give better response or more opportunities, the skilled player should have advanced possibilities. i) Should you fail the challenges, there must be consequences, to make you want to do better next time (Koster, 2005). Koster doesn't have an explicit goal in his definition; nevertheless there is an implicit goal since a challenge carries a goal in itself.

**The six game elements:** The two definitions have been among the prime sources for the six major game elements that should be included in the development of a motivating and engaging learning game. Six of the elements and the nuances, that can make a difference, are described in the details below (also figure 6). It is worth noting that this is an artificial division; they all fit together and are interdependent, as you can see it in Koster and Deterding's descriptions above (figure 6).



**Figure 6: The six game elements are introduced.**

**Goals:** The goals of the game must be motivating, and this will happen if they arouse curiosity, and provide a sense of competence, autonomy and control. Furthermore, they may allow for participation in a social community. The objectives must be clear, structured and "unconflicting". In other words, they must be easy to understand and discern. The player should be able to contribute, to adjust, and to choose his own targets. The fact that you yourself can help to choose your goals brings a sense of freedom, autonomy, and an opportunity for targeting special interests. Besides, what you learn in the game, the skill or knowledge, must be the means to achieve your goal and not the goal in the game (Malone, 1980). The goal should be split into many small and large goals, which will help to provide an overview and a sense of having many small successes. In this way the player can gain ownership in relation to his success and development (Chatfield, 2010). These goals must be linked to each other in a meaningful way, so the game can be experienced as coherent (Schell, 2008).

**Action space:** The game takes place in an action space which must be clear, easy to overview and understand, and consequently easy to act in. In the action space, it is important, that the learning content is a part of the game design. Play and learning must be integrated into each

other in a way that ensures transfer of learning, and not just an ability to play the game well.

Problems and tasks should be presented in the actual elements of the game, and when you use your skill in the game, the game must provide feedback to it. The skills must therefore have an effect on the game/fantasy world (Malone, 1980). Thus, the best game design embeds the learning material deep in the game mechanics, while the choices, motivation and the currently fun items work completely together with the learning goals (Flanagan et al., 2010).

**Choices:** In the game, the player must be able to make some real and meaningful choices. Some of the choices will bring the player forward as desired, others will be mistakes. These choices should be apparent for the player, and must be designed so he can respond intuitively to the choices and learn from what he has chosen. It is important not to punish the wrong decisions, but to encourage the player to try again, now with the new knowledge. It is equally important that the decisions have consequences so two choices do not result in “going the same place”. The frequency of the choices, and the cleverness behind the related consequences are a major part of the fun of the game. There should also be meaning and weight behind the choices, and not just minor differences, this will give the player agency, the ability to act in the game (Iuppa & Borst, 2010).

**Rules:** There must be clear and fair rules in the game. These rules are built into the game, and determine what effect there must be of the choices made by the player. It is important to create motivating rules in the game, since well designed games apparently create a seamless integration of reflexes and "basic -memorization", of all sorts of details of a system. This happens through the player's work on learning a game's rule system's capabilities and limitations, and by means of all the work through the game system (Flanagan et al., 2010).

**Challenges:** The challenges are actually the content in the game, and in every game there will be a main-challenge: In this game the child must learn to play piano by notes. The challenges could be: patterns you have to recognize, rules you have to learn, tasks that should be solved, hand-eye coordination to be learned (Koster, 2005). Challenges must be interesting for the player and the fun is when you understand the pattern, or learn to master the action. The intrinsic motivation is created by the competencies that you wish to achieve by meeting the challenges (Koster, 2005), and the goals and challenges that you succeed in will provide self-esteem. To overcome the challenges the player must know how to solve the problem. Therefore, you need to have access to instruction and help during the challenges. When studying the concepts: *Ludus* and *Paidia* in a game (Deterding, 2011, Denis & Jouvelot, 2004), the challenge may be something you must learn to master: these challenges are rules and resembles a game the most (*Ludus*): for example playing piano by notes. The challenge might also be exploring something which is a creative and more playful challenge (*Paidia*): for example composing a piece of music with scaffolded assistance in a sequencer game.

**Feedback:** In the game the player should have meaningful feedback both on a short and a long term. Feedback is crucial, in order for the player to achieve learning and transfer (of learning) in the game, and thus gain insight into his own efforts. The short-term feedback should be given in such a way that the player gets immediate feedback within 1 ½ seconds on the actions taken (Wilms acc. Weitze, 2011). In this way, the connection between cause and effect is shown. This gives the player the opportunity to experience "learning by doing"(Chatfield, 2010; Kirriemuir & McFarlane, 2006). The long-term feedback can be given as process feedback, that gives the player guidance and strategic feedback; or outcome feedback, that provides information on action-based data. Both kinds of feedback can be instructive and motivating. Furthermore, the

feedback should be of such nature that the player does not lose self-esteem. Thus there is a tension between the need to provide clear performance feedback and at the same time expand the challenge, against the need not to lower the student's self-esteem, so the student/player is discouraged because of the challenge, rather than feeling the urge to go ahead with the task (Malone, 1980). Thus when developing the game, you can work to transform the students feeling from "failing", to the feeling of "not having managed it yet" (Chatfield, 2010). Reward (extrinsic motivation) (Gärdenfors, 2010), is a key component in games (Koster, 2005), and is also a kind of feedback. It is important that the student/player is only rewarded for a real effort in the game, an achievement. By giving rewards, you recognize the player for the effort he/she makes in the game (Chatfield, 2010), and at the same time, you give the player a sense of autonomy (Fullerton, 2008). These rewards are not just medals and earned points, they can, for example, be new and more opportunities, or getting to access a new kind of task, or be allowed to play a favorite song. A guiding concept, when determining the content and strategies of feedback, is that the feedback should correspond to the selected learning, which has required an effort from the player, and should relate to how the player has performed the task. Otherwise, it will feel hollow and meaningless to receive feedback (Deterding, 2011).

## **PART 2: THE CASE OF LEARNING SHEET MUSIC AT THE PIANO.**

In the following, we present the empirical data gathering and analysis techniques that were used to illustrate the concrete design of the music games, and how the design results also gave input to the understanding of the Smiley model elements.

### **The Action Research Case**

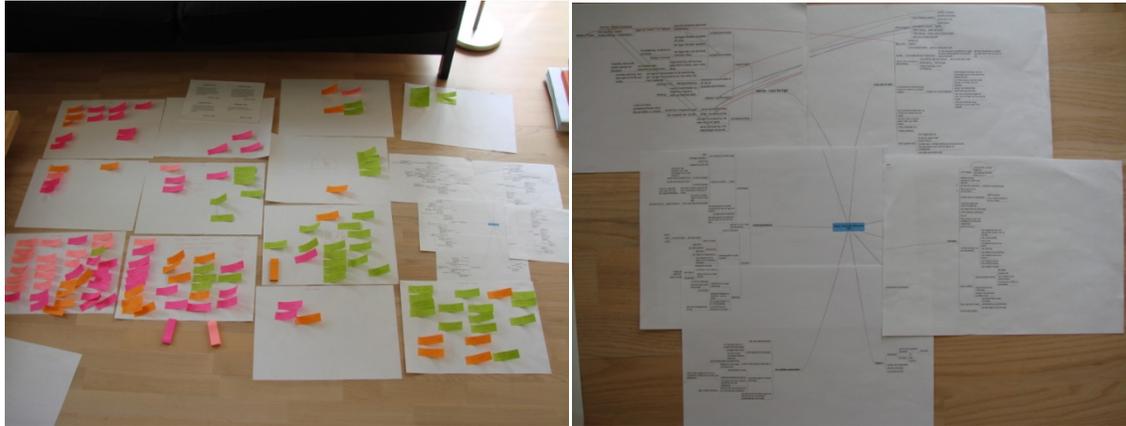
The original problem statement was based on a case: The game company *Tonic Games*, had been working on "Musica", a single-player game for children teaching them to play piano by the use of a music keyboard. This project had a significant amount of resources available; however Tonic Games had used many resources on the development of graphics and programming. It proved complex to design the game in a way that the objectives of providing good and fun learning were met. Tonic games wanted a new proposal for a gameplay that first and foremost was fun to play. At the same time, they wanted the musical keyboard to be a vital part of the game (Weitze, 2011).

As a way of getting inspiration, the mission became to explore various new designs, rather than trying to build on the existing design and hand these new design inputs over to *Tonic Games*, as possible ways forward. This new learning game was named *the Music Game* in the early prototype phase.

### **Methods Applied in the Concept Development**

When designing a concept, you must create space for, and accept a dynamic and iterative design process in many stages. As concept developer, part of the task is keeping the concept in a divergent process, to be open to new perspectives informed by both empirical data and theory, and not to be fixated in your own ideas on the basis of preconceptions (Lövgrén & Stolterman, 2007). In other words, you must accept, that the goal is not clear in advance. You must be

patient, and be ready to take many different development methodologies in use, if the design should be able to achieve a quality, that gives the user an experience that turns into *experience design* (Buxton, 2005).



**Figure 7: Examples of stages in the concept development, brainstorming and mind mapping.**

In this design process, each prototype has been discussed and tested, evaluated and then re-opened in a new divergent phase (Sharp et al, 2011). In the development of the concept, the designer may use different methods or design tools to develop in, and learn from. This could be brainstorming techniques (figure 7), sketching, prototyping (Buxton, 2007), or future workshops. By learning to use these different methods, the designer has an opportunity to "develop his language", and become more and more well formulated design-wise. Thus, the design process can be seen as a mutual learning process, where the user's participate, learn about and give feedback to the design, and the designer learns about the context and the users. Examples of the sketches and prototypes in different phases of the development process are shown in figure 8.

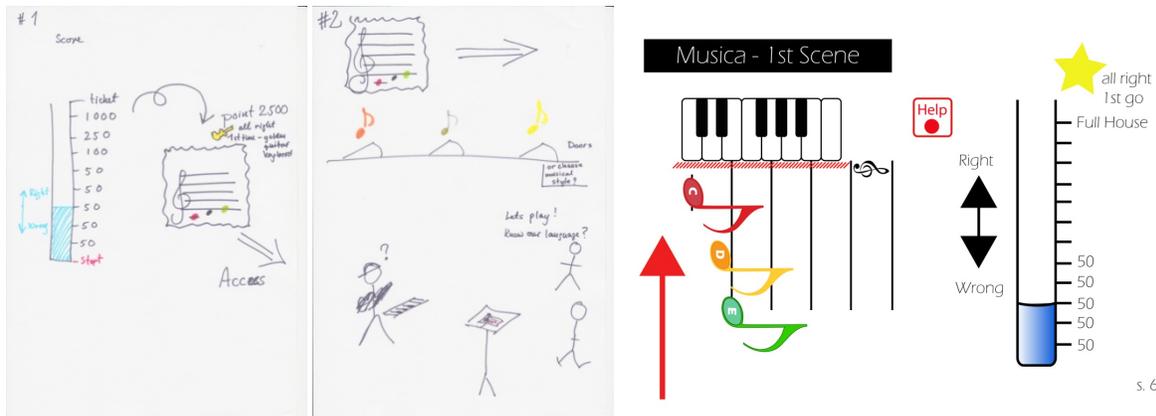


Figure 8: Examples of prototypes

The development of interactivity in a learning game is something that almost requires a 3-dimensional thinking. Ian Bogost, a researcher in video games, speaks of the existence of a *procedural process* when using the computer in a game for "... making arguments with computational systems and for unpacking computational arguments others have created" (Bogost, 2007). In other words, you are organizing and staging a number of possible procedures and rules, both conceptually and algorithmically that users may use in their own way in the game. One of the techniques applied here was sketching (Buxton, 2007). Sketching: The lead author conducting the sketch express: "*When I sketched a scene in the game, where you learn about notes, I for instance realized, that I hadn't thought out the extent to which the figures could be activated by the user, and to what extent the figures should be able to tell "the story of the notes themselves,". This observation appeared when I was drawing a sketch of the "assistance-scene" in the game, and gave an idea of how to rebuild the scene*"(Weitze, 2011).

When you want to create a system where the user and computer interact (HCI), it is advantageous to involve users in the concept development in order to move closer to user needs and product requirements (Sharp et al, 2011). This can be obtained if the designer, throughout the design-development, applies ethnographic methods in the concept development, not in a strict ethnographic sense, but as part of her design methods. Blomberg (1993) argues for using

interviews, and by observing the part of the user's behavior that is not expressed verbally. The documentation in the empirical studies was carried out with note-taking, audio recordings, photographs and video recordings. Participants were selected from convenience sampling (Creswell, 2008). The coding of data was concept-driven as well as data-driven coding, followed by analysis (Kvale, 2008).

In participatory design (PD), the users are seen as co-designers that are able to contribute with valuable design suggestions (Sharp et al, 2011). One way to involve users in PD would be to conduct a workshop, where they could work with different materials and come up with ideas for the design. In the study PD workshops were held with the two target groups: children and parents (figure 9). The ideas, resulting from the workshops, were used as an inspiration for the further design-development. The methodology applied Robert Jungk and Nobert R. Müllerts *future workshop method* for the research design (Jungk & Müllert, 1981). In the research with the children, the children's ability concerning length of concentration was taken into account (Druin, 2002). Materials used for the workshop were similar to children's toys in terms of form and function, since this could help to stimulate natural behavior of the children during the workshop; also, play is a natural medium for children to express themselves in. (Lee and Baek, 2008).



Figure 9: Children and adult workshops

The concept development phases also consisted of peer reviews and cognitive walkthroughs (Sharp et al., 2011; Wilms, 2011). The final user participation in the project was a prototype test following the Wizard of Oz method (Sharp et al., 2011) (figure 10). One of the goals in the prototype test was to examine: how the game concept would be received and function in the target group, whether it was engaging or not.



**Figure 10: The prototype test - Wizard of Oz method**

The figure below shows how the concept development has taken place, changing between empirical research, prototype development, and theory analysis.

CONCEPT MODEL FOR DESIGNING ENGAGING AND MOTIVATING GAMES  
FOR LEARNING - THE SMILEY-MODEL

Concept Development Process			
2011	Empirical studies	Concept - prototypes	Theory
01.02	Own professional background		Reading theory the whole way
01.03	Case		Learning theory
01.03	Studying other games		Serious and Persuasive games
05.03		Prototype: Piano and sheet music given to a boy, age: six years	
09.03	Case: Presentation of comprehension of the assignment to Tonic games. Analysis of the case and other games		Learning Games Development
12.03	User participation: 6-year-old boy tests the 1st prototype		
13.03		2nd: Prototype Drawings and figures/ characters	Sketching and prototyping
18.03	Professional peer review: music teachers		
19.03		3.rd: Prototype with better coherence between the various levels	
21.03	Professional peer review: IT graduate students and primary school teacher		Learning in games
22.03		4th Prototype, going into more technical details with concept	Fun in games
24.03		5th Prototype more detailed drawings of the concept	
25.03	Academic peer review: Presented for the class in Serious and Persuasive games with Rilla Khaled at the ITU.		
18.04	Child Workshop: Participatory design. Presentation of examples of other games to inspire the children, then participatory design with the class, collecting data		Participatory Design, also for children, future workshops, interviews, video observation,
21.04	Adult Workshop: Participatory design and brainstorm methods, 3d video sketch, etc.		Prototype sketching
27.04	Walkthrough: Inge Wilms meeting		Memory, attention
13.06		6th Prototype	
16.06	Prototype Test for children		

Figure 11: The Concept Development Process

### **Findings from the Empirical Data Material**

In the study there were examples of three types of observations: observation of new phenomena, conflicting observations, and confirmatory observations. These were investigated, and compared to the discovered themes from the theoretical and empirical analysis. The following shows two significant examples on how the design has changed on the basis of empirical findings (Weitze, 2001).

**New observations:** *Community and Ensemble playing:* In the first iteration, it was chosen not to use any community / social software features in the design to keep the game elements simple for the young target group. However, in the adult workshop, it was suggested that the children should be able to play the game together with others, as it happens in other commercial games, because the parents felt, that this was important for the children's involvement in the game.

In the prototype test, two boys chose to sit together at the piano, where they competed against each other as well as cooperated (figure 12). Spontaneously, they decided to choose the hardest song they could find, and then divided the piano keys between the two of them. This corresponds to the research consultancy work of the researcher involved, in which users of digital learning materials (in particular in collaborating teams) starts with “playing with the material” by investigating the boundaries; trying something which is deliberately wrong, to see what happens; or, as in this situation trying the hardest levels in the game. In this situation, the two children helped each other, had great fun, and kept on playing for a long time.

Since the issue of collaboration emerged both in the adult workshop and in the prototype test among the children, the design decision was changed. In the final prototype test it was very obvious how much pleasure the children had in interacting with each other. This idea has been

implemented in the concept of a potential opportunity to play with other musicians, as in the game *Rock Band 3*.



Figure 12: Ensemble playing, the joy of playing together

**Confirmation of initial assumptions:** *Flexibility:* One of the girls wanted to try out the 2<sup>nd</sup> level in the game. At first she was a little confused, and found it difficult. She then asked the workshop facilitator, Charlotte Weitze, to slow down the tempo. She practiced diligently, and then came back five minutes later and told Charlotte that she was now able to play it at a fast tempo with all the right notes (Figure 13). A boy wanted to try the same as well, but found it so difficult that he completely gave up. The finding here is that the game should be flexible and adaptable to the individual's learning pace, and it should suggest alternatives if the task is too difficult. The game must be able to store data from each player's profile, and keep data on how quickly the student progresses, and let the task's difficulty level increase according to the individual child's player profile.



Figure 13: Girl training the game

**Rhythm Games:** In the thesis, other Rhythm-Games in the genre were analyzed. This included: Keyboard Mania, Rock Band 3 Pro Keys, Sibelius Groovy City, Piano Wizard and Piano Dust Buster. The Music Game is a new iteration of these Rhythm-Games, which has an increased focus on transfer of learning, compared to most of the other games in the genre.

### **Discussion**

The choice of action research as the overall method, combined with the iterative interaction design model has been suitable for carrying out informed concept development. This exploratory approach has taken the development process in a direction that a concept development without the user participation would not have allowed for. Through user involvement, one of the significant changes has been, that the learning game concept has moved from being a single-player game to being a flexible Music Game implemented in a larger learning environment, which provides opportunities for learning, collaboration, knowledge sharing and competition in the community (Weitze, 2011).

Through the development of the Music Game concept, and by using action research it has been possible to develop guidelines on: what may contribute to the development of a motivating gameplay in the game, and research shows that this can be advantageous to do in a learning game-development process, prior to beginning the big graphical and programming work. This is of course partially a contention, because the finished product has not been developed and programmed yet. But observations of users in the empirical studies are initially showing that it has been possible to create design guidelines, and based on these: a learning game concept that will be engaging and motivating to use.

### General Findings – The Smiley-model

In the following the resulting Smiley model are outlined for overview and inspirational purposes (figure 14).

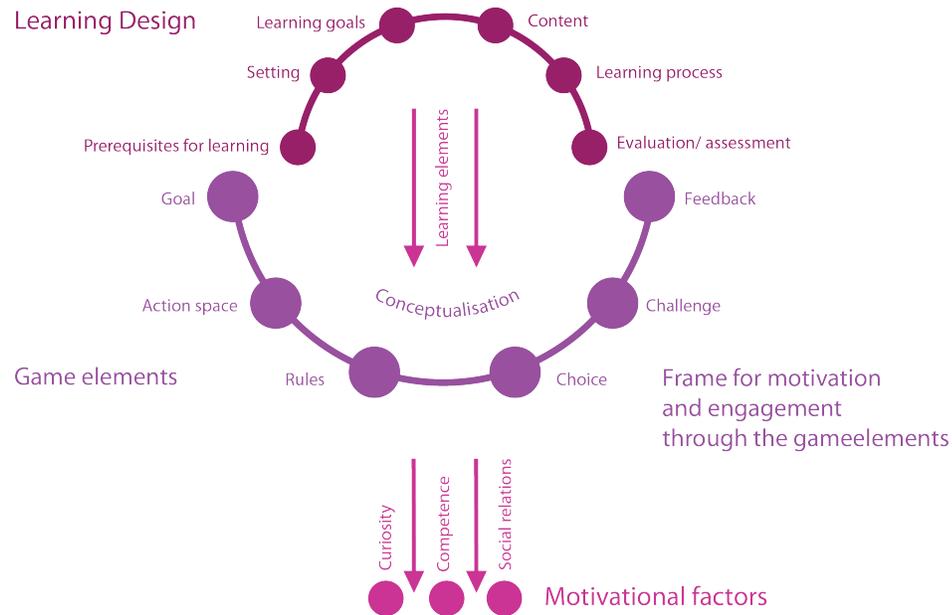


Figure 14: The "Smiley-model"

**Learning Design: Prerequisites & Setting:** Prerequisites of the audience: age and interest in the subject, as well as the setting: with the physical keyboard and computer. In this case the *Learning goal*: is about learning to play piano by notes, and it has to be presented in a professionally relevant, meaningful, and clear way. It is a good idea to show the goals as levels of competence, so the student experiences a clear progression. The *Content* is the challenge in the game; therefore it is really important that it is "served" in a way that makes it fun for the child. It has to be fun for the child to achieve competence in playing and mastering the notes. The content must come at the right time and place, according to the student's level of competence. *Learning process*: In the current situation it was important to have both the possibility to receive instruction and to practice how to learn to play the piano. The game should instruct and demonstrate the tacit knowledge and skill learning through graphics and sound, and

allow the student to observe, and then imitate on the physical keyboard. Thus, he will learn the notes and develop his psychomotoric skills. In order for the student to feel sufficiently challenged, different difficulty levels of the tasks can be developed. When user data from each player's profile is stored, the game will be adaptive to each student, and the game will allow for small successes all the time, it allows for a sense of mastery. *Evaluation:* To achieve transfer, it is very important to make demands that match the requirements in the "real world" (Iuppa & Borst, 2010). Therefore, the game must give an on-going feedback to the student, to always let him have a sense of his own level, and of what he is doing right and wrong.

**Learning element:** In the above context you now select a learning element for a specific place in the game. An example: The student must learn the notes A and B under the conditions just mentioned. This learning element is then designed using the motivational factors and game elements, but keeping in mind the backdrop of the context which has just been defined.

**Motivational factors:** In the next step, we want the learner to experience an inner motivation to play the game, and to learn the two notes. This could be accomplished if the student feels: 1) *Curious*, 2) or experiences *having competence/ mastering something*, the feeling of agency, 3) or experiences *a positive feeling of belonging to a social community*.

**The six game elements for engagement and motivation in a learning game:** In order to support inner motivation, the learning elements (notes A and B) needs to be designed through the 6 game elements, where the motivational factors (1 to 3 in the above) are used as guiding objectives. Therefore you need to keep the motivational factors in mind, when you make design choices within the six game elements. As is the *Goals:* What you learn in the game, the skill or knowledge, must be the *means* to achieve your goals and not the actual goal of the game. The goals of the game should be motivating. They should arouse one or more of the three

motivational factors. The goals should be clear and structured. This may be achieved by letting the student/player adjust and choose his own goals. The goals must be linked to each other in a meaningful way. The goal of the child could for instance be to reach level 2 of the game, which uses note A, and B, and gives new and fun possibilities to play using your new competences. Then learning note A, and B will not be an explicit goal of the child, but a means to reach the goal. Concerning *Action space*, it is important to have a well-developed narrative, and a graphically beautiful, and meaningful universe. Another thing to consider here, is to make sure that when the player is either completing or not completing a challenge, this should make changes happen in the universe of the game. Thus, reaching level 2 could mean changes to the spatial surrounding or to the features and navigation options available in that space closely connected to the learning goals. *Choices*: In the game, the player must have the possibility to make substantial and meaningful choices, since this will give him a feeling of agency. The choices should be clear and intuitively designed, so the player can respond and learn from it. There should be cleverness behind the consequences, and the player should be encouraged to try again if something doesn't work out. *Rules*: The rules are what you must *learn* in the game. They have to be clear and fair, and should be "embedded in the game mechanics" that is: What you *do* in the game. The consequences of the choices, the player makes, are determined by the rules. It is important to create motivating rules in the game, as playing the game and learning a game's rules, apparently helps to create a seamless integration of reflexes and "basic rote-learning". One rule could be that the notes A and B are linked to two specific keys at the keyboard, and you have to press the right keys at the right time in order to proceed in the game. *Challenges*: The challenges are the content, or *what we want the player to learn* in the game. The assignment must be qualifying, measurable, and an "easy eatable bite" which is satisfying to learn, to master,

and become good at. According to Koster, it is learning, which is the fun in the challenge (Koster, 2005). The challenges should be created in an interesting way for the player, since the intrinsic motivation emerges because of the competencies that he wishes to achieve. *Feedback*: you should give the player meaningful feedback in order to let him obtain learning and transfer in the game. This will give him insight into his own effort and abilities. The short-term or immediate feedback will show the connection between cause and effect, and the player will experience "learning by doing". If the player hits the wrong key it turns red in the interface. However, in order to learn it is also necessary with long-term feedback that guides the student/player (*process feedback*). This could be *strategic feedback*: "you should try only to practice with one hand at a time", or *outcome feedback*: "you have hit four out of six A's correct in this piece of music". The concept of "Fun", (here implemented through the game elements) is a central and serious design value, if you want to develop an engaging learning game and arouse the student's intrinsic motivation (Weitze, 2011).

### **Conclusion**

In this research we found that if a child is going to learn to play the piano in the game this will require: demonstration, instruction, and an opportunity for repeated, varied training with feedback, and with the opportunity to train on a physical keyboard in the game. If the learning game should also be motivating and engaging, the learning must be the means, and not the goal in the game. The learning should be implemented in "well-designed bites" for the player, and you should be careful and thorough when prioritizing and conceptualizing the learning elements.

The study found that if you want to create motivation in the game, the three main driving forces are: curiosity, competence, and reciprocity. You must zealously and innovatively develop and adapt *the nuances in*, and the *conceptualization of* the following six game elements in games

for learning: goals, action spaces, rules, choices, challenges and feedback, as they help to provide the motivating forces. According to the present study, this could be a way to reach the serious, respectable, and core design value: *fun* in the educational game. This is summarized in the Smiley-model. The concept of *the Music Game* was developed through user involvement and by using the developed "design manual". This manual was condensed into the "Smiley-model" which answers the research question. The Smiley-model was used as an inspirational and heuristic tool in the design process.

It is the hope that the parameters in the Smiley-model will inspire to further investigation on how to make engaging learning games. The model has lately been used to analyze learning environments such as Khan Academy and Codecademy, and it has also been used for proposing how to design a learning game that teaches and gamifies how to use Facebook as a marketing media. Thus, the Smiley-model has given a vocabulary to the discussion of parameters in engaging learning games. Regarding the generalizability in the design manual's recommendations on how to create an instructive, fun and motivating music learning game, it is suggested, that the model may be used as an inspiration for the design of other learning games. This requires that you take into account, which subject is taught, and *what* should be learned when choosing the learning type as the first frame in the Smiley-model *learning design* points to. Furthermore, you should be careful how you conceptualize the learning elements and implement them in the six game elements.

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