

DESIGNING A PERSUASIVE GAME FOR CHILDREN'S SAFETY AWARENESS

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Children encounter many dangers at home and in their surroundings during their daily lives. Safety education before the school age is important for the children to form safe behaviors already early in their lives, but a persistent problem for reaching young populations has been the lack of engaging materials. Hence, there is a need for developing engaging, interactive materials, such as games, to help children adapt necessary safety behaviors effectively.

The purpose of this study is, through constructive research, to examine 1) how can a persuasive game be designed to increase children's safety awareness in their early childhood, and 2) which good practices and guidelines can be derived from the design process.

In collaboration with Tukes, the Finnish Safety and Chemicals Agency and Yle, the Finnish Broadcasting Company, a mobile game was developed with the agenda of increasing children's safety awareness. Action Design Research (ADR) methodology is used to describe the design process, containing four phases: Problem Formulation, Building, Intervention and Evaluation, Reflection and Learning, and Formalization of Learning. As the theoretical background, the concept of procedural rhetoric and the prior research knowledge on children's user-centered interaction design were adapted. The resulting game was evaluated through playtesting with the co-discovery method and a feedback survey.

During the project, a functioning persuasive game was designed through an iterative process. The reflection and learning upon the design process also resulted in a process model for persuasive game design and set of guidelines to help guide children's persuasive game projects in the future.

The study was limited by the fact that the long-term effects of the game intervention on children's safety awareness were not monitored. Future research on the topic should address the measurement of long-term effects of persuasive games, as well as study their design and implementation in different contexts, environments, and user groups.

Keywords: *persuasive games, safety education, game design, game design research, gamification*

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1 INTRODUCTION

Children encounter many dangers at home and in their surroundings during their daily lives. In 2010–2012, children under the age of 7 faced an average of 17 fatal accidents, and 2,700 children received care in hospital ward due to an accident (Tukes, 2015a). Most common safety risks for children include traffic accidents, drowning, suffocation and poisoning (ibid.). To raise public awareness on safety issues, individuals must adapt proper attitudes towards everyday safety behaviors. Changing attitudes is a long-term process, so it is important to reach children in their early childhood. Improving children's safety education will potentially result in safer behaviors and a decrease in accidents for decades to come. Hence, new potential means are needed to provide small children with engaging safety education.

Information technology, games and gaming are an increasingly bigger part of our everyday lives. According to The Finnish Player Barometer 2015 (Mäyrä, Karvinen & Ermi, 2015), 60.1% of the Finnish population play digital games actively, while 75% are occasional players. Most rapidly growing player group are mobile gamers: nearly 37.2% of the population uses a smartphone or a tablet for playing games at least once a month. Mobile gaming is often considered as “casual” play that requires less concentration than traditional digital games (cf. Kultima, 2009). Touch screen-based technologies also increase children's independent web use, as they learn touching icons and controls more easily than using a traditional computer (Noppiari, 2014). Five-year old children may play one to two hours a day, including both digital games and tabletop games. The uprising of mobile gaming has expanded the spaces for playing from home to all everyday environments: in 2013, children recounted playing mobile games at home, in the classroom, at the cabin, on the way to hobbies, or at the mall (Noppiari, 2014).

As games have become such a ubiquitous part of our social reality, there have been developments to benefit from games as vehicles for societal change. Using game design in real-world contexts has been seen as way to for example facilitate large scale collaboration and increase self-motivation in our everyday chores (McGonigal, 2011). Many businesses have also adapted engaging game experiences as a way to enhance services in order to support value creation for the users (Huotari & Hamari, 2012). These “gameful” experiences may appear in the form of individual game elements or

affordances (Deterding et al., 2011), or full-fledged “persuasive” games: games being a highly expressive medium, they have been widely used to influence people’s opinions, attitudes and behaviors through their inherent procedural rhetoric (Bogost, 2007). Using games as a mean to provide engaging safety information to children could help a large population segment to adopt good safety behaviors already in their early childhood. For this purpose, the persuasive game Pikin huone (“Piki’s room”) was developed.

Prior research has been conducted on teaching children safety skills through computer games or virtual worlds in the context of fire safety (Smith & Ericson, 2009; Padgett, Strickland, & Coles, 2006), traffic safety (Dunwell, de Freitas, Petridis, Hendrix, Arnab, Lamerias, & Stewart, 2014; Liu, 2006), or both (Coles, Strickland, Padgett, & Bellmoff, 2007), but these studies have provided little information on the actual design process and the organizational context involved. Hence, this thesis will study the process of designing a persuasive mobile game Pikin huone to increase children’s safety awareness and reflect on the outcomes and the potential issues encountered. The thesis seeks to answer the following research questions:

- 1. How can a persuasive game be designed to increase children’s safety awareness in their early childhood?*
- 2. What are the practices and guidelines that can be derived from the outcomes for developing persuasive games for children?*

The design processes of games are often studied in the field of game studies: a “multidisciplinary field of study and learning with games and related phenomena as its subject matter” (Mäyrä, 2008, 6). Research in game studies is primarily conducted under three main areas: study of games and their structures, understanding players and play behaviors, and game design and development research (Mäyrä, 2008, 156). This thesis study will mainly operate under game design research, seeking to contribute to the knowledge through a designed artifact. As digital games are essentially software products, the research method here is adapted from related field of study for the design and use of software-based systems.

Olsson (2015) states that in game design research, the chosen method of investigation should dictate the structure of the majority of the text. Following this advice, the structure of this thesis adheres to the Action Design Research (ADR) methodology

introduced by Sein, Henfridsson, Purao, Rossi & Lindgren, (2011). After this introduction, chapter 2 introduces the research methodology. Chapter 3 provides the practical basis, as well as the theoretical background for the ADR process. Chapter 4 goes through the game design process, corresponding to the Building, Intervention and Evaluation phase in ADR. Chapter 5 aspires to formalize the lessons learned from the process into generalizable design principles and a suggested process model for persuasive game design. Chapter 6 provides conclusions.

2 RESEARCH METHODOLOGY

This chapter positions this study within the field of game studies and the related disciplines, and introduces Action Design Research as its methodological framework.

2.1 Positioning the Research

This thesis attempts to create knowledge via constructive design research. As the studied artifact here is a digital game, this study falls under the interdisciplinary academic field of game studies. While game studies can be viewed as an independent academic structure as advocated by Aarseth (2001), the scholars working in the field come from a wide array of disciplinary identities (Mäyrä, van Looy, & Thorsten, 2013). In his introductory book to the field, Mäyrä (2008, 156) suggests a game studies project to pursue knowledge by exploiting a toolbox of methods from the humanities, social sciences, and design research. Recently the role of design research has been emphasized within the discipline, even situating “design orientation” in the core of game studies (Deterding, 2014) or suggesting the field should take “design turn” (Kultima, 2015).

Cross (2001) sees the roots of combining design and research in the 1920s, when the Modern Movement and artists and architects such as Theo van Doesburg and Le Corbusier wanted to advance the works of art and design being based on objectivity and rationality. The second milestone emerged in the form of the 1960s design method movement with The Conference on Design Methods being established, marking the launch of design methodology as its own scientific field. Since then, it has developed through a major backlash against the rational method in the 1970s and a new resurgence of journals of design research, theory and methodology in the 1980s and 1990s. Cross (ibid.) differentiates between three different interpretations on the relationship of science and design: scientific design reflecting the modern industrial design based on scientific knowledge; design science as an organized, rational and systematic approach to design; and the science of design referring to studies in understanding of design through scientific methods. Cross proposes that as design, as a discipline, should remain a reflective practice to study the world via the special knowledge and abilities the designers have despite their different domains of practice.

Kultima (2015) and Kuittinen & Holopainen (2009) have made effort to connect game design research into general design research methodologies, theory and practices. Kuittinen and Holopainen have facilitated applying the theoretical models from design research in game design, as they argue the approach has been lacking on the prior literature. Similarly, Kultima points out that game design research has been very much connected with the professional practice of game design, using game design guidebooks as primarily references and relying heavily on industry collaboration. The existing literature on game design has been indeed considerably practice-oriented: it has provided conceptual frameworks (Salen & Zimmermann, 2004), assistive lenses (Schell, 2014), design patterns (Björk & Holopainen, 2004) or processes (Fullerton, 2004) to guide the practice of game design.

As digital games are essentially software artifacts, game design research can also benefit from the approaches and methodologies in fields that study the design, implementation and use of software-based systems, such as Informations Systems (IS) and Human-Computer Interaction (HCI). Kuutti (2007) argues that both IS and HCI are both essentially design-oriented disciplines: in IS the focus is on studying how the functions of organizations can be redesigned and improved through the use of information technology, while HCI focuses on designing the interaction between information technology and its users. According to Kuutti (ibid.), the research in IS targets the Mode 1 type of knowledge production, pursuing for scientifically rigorous, theoretical contributions that have less impact on the practitioners, while the knowledge produced in HCI is more of Mode 2 type applied knowledge with close ties to industry practice.

This thesis is positioned in the academic discipline of game studies, seeking to make contribution through game design research. To provide a rigorous framework to produce new knowledge from a design process conducted in an organizational context, Action Design Research methodology is adapted from the IS discipline. To provide theoretical guidance for the design process, we utilize the knowledge base of both game studies and HCI.

2.2 Action Design Research

Design science research is an approach within the IS discipline to produce knowledge from design that is relevant for practitioners. Hevner, March, Park, & Ram (2004) present the following general guidelines for design science research:

1. **Design as an Artifact:** The research ensues in a functioning artifact, such as a model, method, construct or an instantiation.
2. **Problem Relevance:** The produced solutions address relevant issues in the problem domain.
3. **Design Evaluation:** The utility, quality and efficacy of the produced artifact are evaluated against valid metrics.
4. **Research contributions:** Design science research should represent verifiable contributions in the design artifact, foundations, and methodologies areas.
5. **Research rigor:** Building and evaluation of the artifact uses rigorous methods.
6. **Design as a Search Process:** Design takes place through an iterative process.
7. **Communication of Research:** The outcomes of research are effectively communicated to relevant audiences.

There have been several frameworks presented to carry out design science research, such as the Design Science Research Methodology presented by Peffers, Tuunanen, Rotherberger, & Chatterjee (2008). However, these frameworks have been presented as stage-gate models that place the evaluation phase after the design and development phase, which does not reflect well iterative processes such as game development. To address this issue, Action Design Research has been presented as a constructive research method that combines action research and design research (Sein et al, 2011). It is a commonly used research methodology in IS research, and has also been used to guide constructive research on games and gamified systems in different contexts. For example, Schacht, Morana & Maedche (2014) have priorly used the method to inspect implementing game mechanics into a knowledge management

system, and Coenen (2014) has used it for studying the design and evaluation of a pervasive engagement game in a city neighborhood.

Sein et al. (2011) presented ADR methodology for creating prescriptive design knowledge through two ways: (1) addressing a certain problem situation in an organizational setting by means of intervention and evaluation and (2) constructing and evaluating an artifact to respond to such situation. In the case of this thesis, the problem situation was that the organization is lacking a method to reach pre-school age children to spread information related to safety. The artifact constructed will be the persuasive game designed to address this problem. The evaluation of the artifact will reflect how well the resulting artifact succeeds in solving the problem: the game should be both useful in presenting the safety information and engaging for the children to play.

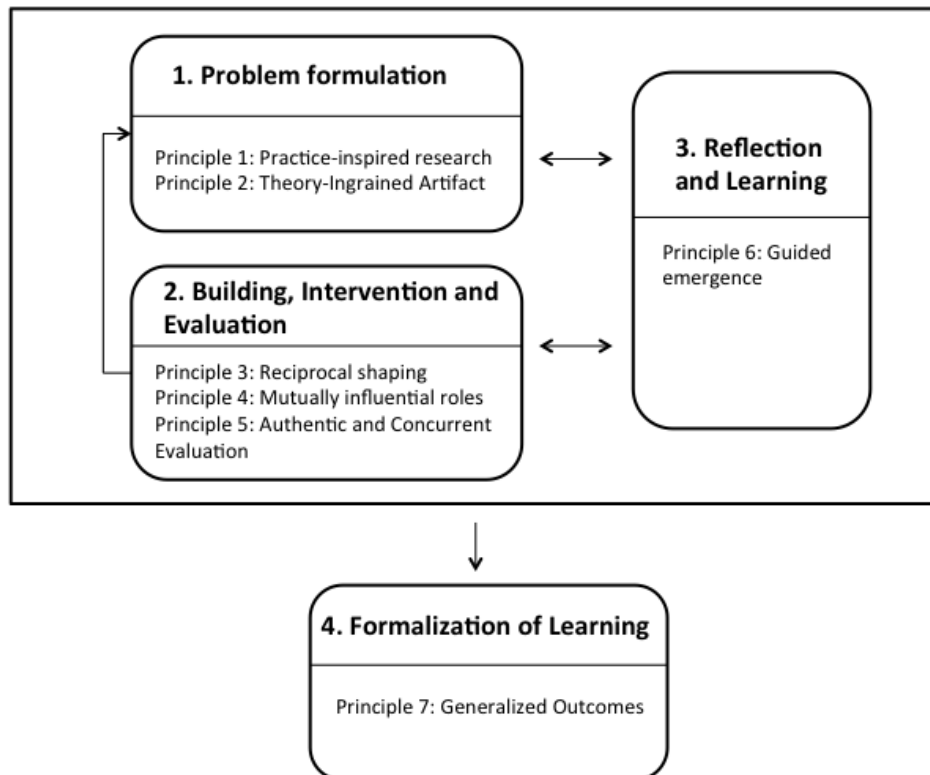


Figure 1. Action Design Research process.

According to Sein et al. (2011), an ADR project takes place in four phases: (1) Problem Formulation, (2) Building, Intervention and Evaluation (BIE), (3) Reflection and Learning, and (4) Formalization of Learning (see Figure 1). Each of these phases incorporate principles which to follow. The Reflection and Learning stage should take place continuously along both Problem Formulation and BIE phases in order to evaluate

the applicability of the solutions into broader problem contexts. Formalization of Learning stage then is meant to make the observations from previous stages into generalizable knowledge. In more detail:

Stage 1: Problem Formulation includes identifying and conceptualizing the research opportunity at hand based on prior technological and theoretical knowledge. The stage draws on the principles of practice-inspired research and theory-ingrained artifact. The first principle emphasizes how the knowledge-creation opportunity stems from a real-world problem, while the latter addresses that the artifact produced must be informed by scientific theories.

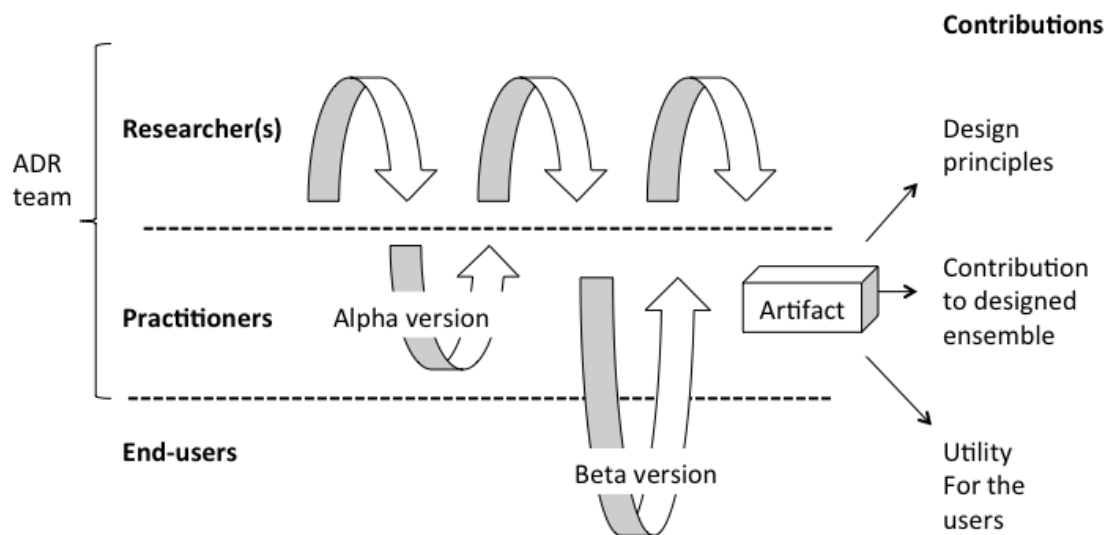


Figure 2. IT-dominant BIE process.

Stage 2: Building, Intervention and Evaluation uses the premises set in the first stage to drive an iterative process of building, applying and evaluating the problem-solving artifact. There are two possible endpoints for the cycle: in **IT-dominant BIE** (see Figure 2), an alpha version is first produced to be taken into use within the organisation, later followed by a beta version reaching end-users. In **organizational-dominant BIE**, the alpha version is already deployed to the end-users. The principles to be followed include reciprocal shaping, mutually influential roles, and authentic and concurrent

evaluation. They emphasize how the organizational context and the IT artifact mutually influence each other, how project participants of different backgrounds learn from each other, and how evaluation should not be separate but continuing stage of the research process.

Stage 3: Reflection and Learning emphasizes constant conscious reflection on the problem framing, informing theories, and the emerging creation. Its principle of guided emergence depicts the way the artifact design is continuously shaped by the views of researchers, organization and participant users. Tasks to be done during the phase include reflection on the designs, evaluating adherence to guiding principles, and analyzing the results according to the set goals.

Stage 4: Formalization of Learning can actualize as design principles generalized to accommodate a broader problem context or possibly refinements to initial informing theories. The guiding principle of generalized outcomes suggests conceptualization of outcomes through three phases: generalization of problem instance, generalization of solution instance, and derivation of design principles.

The following chapters of this study will roughly follow the four stages of the ADR method. Stages 2 and 3 are combined into one chapter since the reflection and learning happen along the design cycles. Each stage will describe the method's appliance into the research problem.

3 PROBLEM FORMULATION

This chapter corresponds with the Building, Intervention and Evaluation, and Reflection and Learning phases of the ADR methodology. The iterative design and evaluation process of the alpha and beta versions of the Pikin huone game is presented.

3.1 ADR Principle 1: Practice inspired research

The initiation for this project came from Tukes, the Finnish Safety and Chemicals Agency, on whose agenda is, among other governmental duties, to educate Finnish children on good safety practices and behaviors. Reaching children before their school age is important in order for them to learn safe behavior already early in their lives: this will help them grow up to be responsible citizens and decrease the amount of accidents they are exposed to. However, a persistent problem for reaching children under the school age has been the lack of engaging materials. Tukes has provided brochures for the parents for example about home and traffic safety, but has not been able to reach the children directly. Hence, there is a need for developing engaging, interactive materials to help children adopt safe behaviors. Tukes saw that an interactive game could be one potential form to reach the young population.

To develop a persuasive game for increasing children's safety awareness, Tukes accomplished collaboration with the Demola Network, an innovation hub that facilitates multidisciplinary student teams to develop solutions for different organizational needs. The appointed student team included students from three schools of higher education in Tampere. Demola provided the facilitation and the premises for the project, while Tukes provided guidance on the safety information and feedback on the designs. The project was carried out over two semesters in 2014. The latter semester also brought Yle, The Finnish Broadcasting Company as an additional participant organization who provided the technological publication platform for the game.

3.2 ADR Principle 2: Theory-ingrained artifact

The theoretical background for informing the game design is adapted from two main sources: the concept of procedural rhetoric and the User-Centered Design (UCD)

practice, especially the prior work on children's interaction design research. The concept of procedural rhetoric has been widely used in the field of game studies to understand how games influence their player through their distinctive expressive means. We deploy procedural rhetoric as a framework to express the intended safety procedures via game design. Using the knowledge from UCD practice with children as users is used to be to understand children's distinctive qualities as interactive media users in the design process.

3.3 Procedural Rhetoric

Bogost (2007) uses the term procedural rhetoric to describe the representational form inherent to video games. Video games in general have historically been considered a form of play – a leisure activity – that has no serious or productive purposes. This though, can be seen as a misunderstanding of the nature of play. According to Salen & Zimmerman (2003, 80) definition, play is “the free space of movement within a more rigid structure” – play can be understood as a possibility space within set constraints. In video games, the player explores the possibility space in the game by manipulating the symbolic systems of the game. Processes – or procedures – are sets of constraints that create possibility spaces for the player to explore. Murray (1998) has presented proceduralism as one the essential properties of digital artifact. In computing, procedural systems use algorithms to generate behaviors, based on rule-based models. Video games often have emphasis on proceduralism since they pursue to create complicated models of the material world. Bogost (2007) argues that through video games, players can learn both about the world that the game models, as well as about proceduralism itself as the heuristic and algorithmic approach to things.

Beyond building a game world for the player to explore, some games use procedural representations to make claims or arguments about some aspects of human experience. Since study of argumentation is usually conducted under the domain of rhetoric, Bogost (2007) has uses procedural rhetoric to describe the practice of using processes for persuasive and expressive purposes. The arguments in procedural rhetoric are made through construction of rules: in video games, the ones authored through the programming of algorithms. Procedural rhetoric can make people understand how things work by making them use and see the underlying processes in the models

depicting real-world systems. This applies not just to games that model material objects like flight simulators, but also those that interpret conceptual systems, like social or cultural systems such as consumer capitalism. Hence, Bogost argues that one potential use of studying procedural rhetoric can be to reveal the ideologies that drive social, political or cultural behavior. Bogost calls games that use procedural rhetoric to make arguments persuasive games. Examples categories of such games include political games, that intend to affect people's political and ideological viewpoints or attitudes, advertising games, which use gaming for marketing purposes, and learning games, including educational games and "exergames", which urge people to exercise.

A recent example of a procedural rhetoric in practice within the safety context can be found in *Dumb Ways to Die*, a train safety awareness campaign by the Australian company Metro Trains Melbourne. The campaign consists of an animated music video, a website, and a mobile game application (*Dumb Ways to Die*, 2014). The game features abstract human-like cartoon characters, which are engaged in situations that expose them to danger. The player has to make the characters evade trauma by using different interaction techniques, such as tilting the device, making a sound by blowing, or using different touch gestures. Although a majority of the sections in the game are not related to trains, the main intent of persuasion expressed through the procedural rhetoric is to make the player more aware of risks around trains and railroads.

Although providing means to understand persuasion made through video games, the study of procedural rhetoric is in many ways theoretical and hence very difficult to measure empirically. It focuses on the interpretation and identification of persuasive argumentation in games, rather than providing practical advice on how to design persuasive games. Rao (2013) has stated that the procedural rhetoric seems to have provided ground for studies rather concerning digital games as representational medium with complex expressive content than actually studying the of persuasive qualities and efficacy of games. An example of the former is the study by Bernard & Mads (2015), who use the concept for evaluating the embedded ideological narratives in two strategy games. Concerning persuasive game design, Ferrara (2013) has presented five loose guidelines for designing persuasive games, but his advice seems to be mostly anecdotal. Iacovides & Cox (2015) on the other hand have used the concept of procedural rhetoric as a part of their study of serious experience in digital games. Their approach to evaluate the persuasion outcomes was through both playtesting and experts judging

persuasive games that were entries submitted for a game design competition. More comprehensive methods for evaluating the successfulness of procedural rhetorics seems to be however lacking in the literature.

3.4 Children and User-Centered Design

Children are a special group of interactive media users. When studying or designing children's user experiences, the user research methods should be appropriate to their skills and special qualities. The HCI discipline provides many studies on the applicability of different research methods on studying children's user experience (UX). Children can also provide important assistance during the design phase of products. Using proper methods will help better understand children as users and guide the design decisions.

Children have many distinctive features that separate them from adults as interactive media users. When people grow up, their physical and cognitive capabilities change over time, meaning that children in different ages have different needs for the products. Bruckman, Bandlow, and Forte (2012, 795) mention five relevant characters of children regarding HCI research: dexterity, speech, reading, background knowledge, and interaction style. Concerning dexterity, it should be minded that children still have developing fine motor control, and they may not be able to use input devices such as mouse for intricate tasks. Speech recognition techniques may have problems if there are no specific acoustic models for children. Pre-literate children need to be provided information through audio, graphics and animation instead of text, and for those who know to read, text size should be big enough. When designing interfaces, metaphors from the adult world should be avoided, since children may lack adequate background knowledge to understand them. Similarly, children's attention and interaction patterns may be different. Children's interactions are often of spontaneous and playful nature, so simplicity should be emphasized over advanced functionalities. They may even showcase totally unique interaction styles that the designers may not anticipate. Children are also prone to use technology collaboratively, for example working together on a computer. (Bruckman et al., 2012)

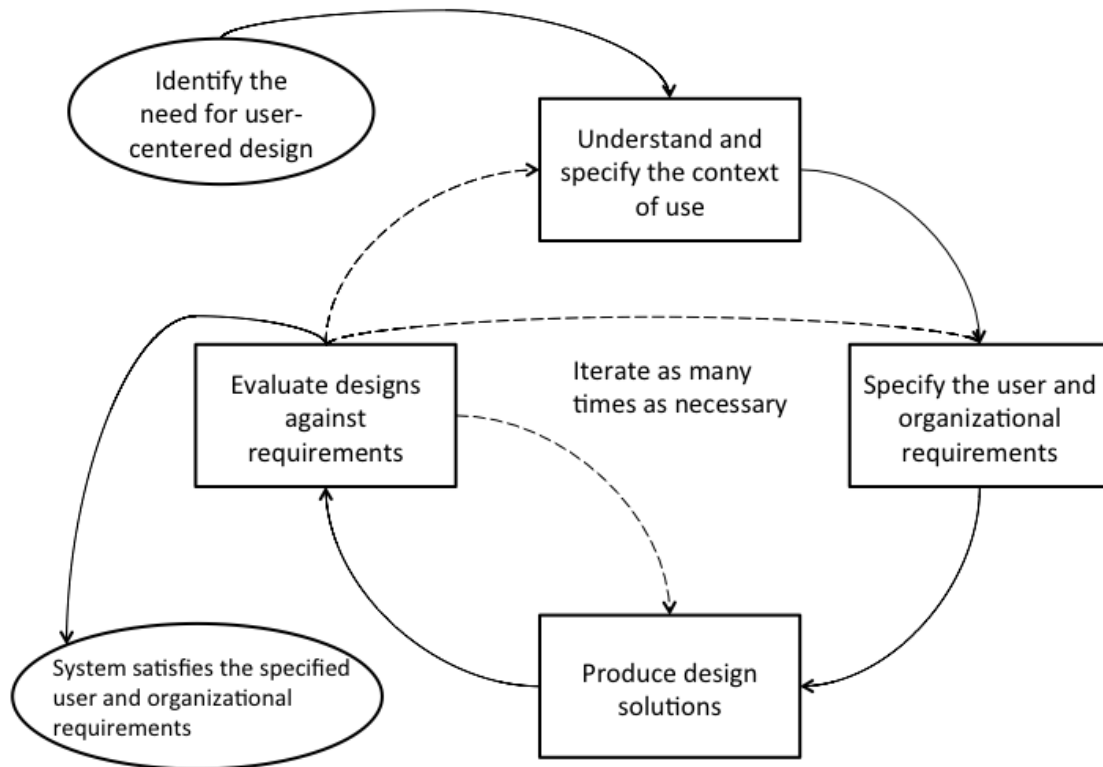


Figure 3. Human-centric design process.

One of the most prominent approaches for designing interactive systems is user-centered design, also called human-centric design. The ISO 9241-210:2010 (2010) standard for human-centric design processes for interactive systems defined four steps in the iterative design process: 1) understanding and specifying the user context, 2) specifying the user requirements, 3) producing design solutions to meet user requirements and 4) evaluating against the requirements (see Figure 3 for visualization). Participatory and ethnographic methods may be used in discovering the user requirements. The process bears resemblance to the iterative process presented in the play-centric approach to game-design by Fullerton (2008, 15), which consists of phases of generating, formalizing and testing ideas, and evaluating results (see Figure 4). Fullerton emphasizes the use of playtesting the product on different phases of the design process for testing the ideas, also already on the early prototyping phase.

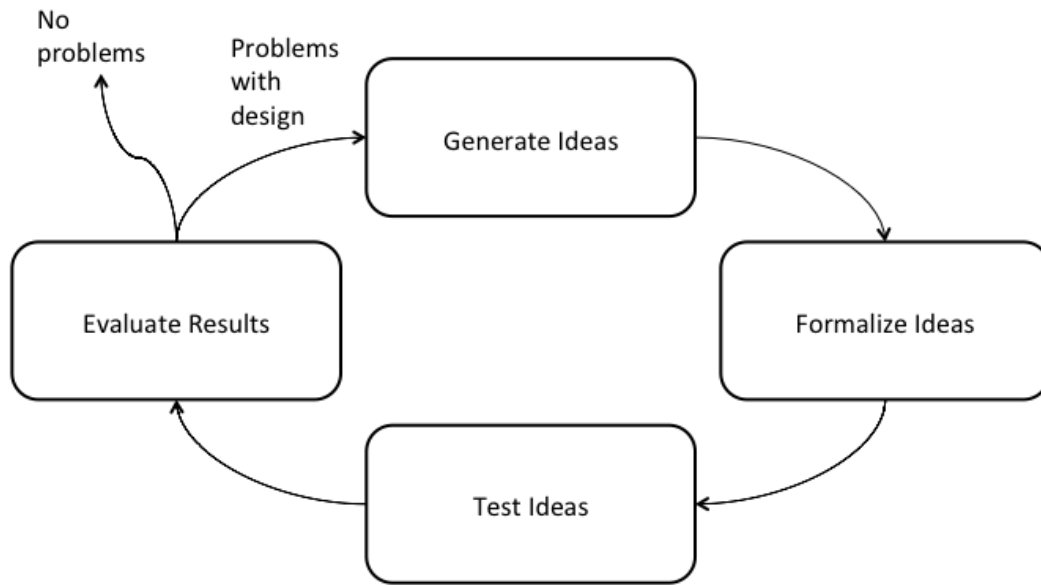


Figure 4. Play-centric design model.

Involving children as users in user-centered design has its own challenges for research. Druin (2002) presents that children have four possible roles in technology design: user, tester, informant, and design partner. As users they contribute by using technology, being observed by the researchers to understand the its impacts. As testers, they may test prototypes and give comments to aid future iterations. As informants, they may participate during different stages of design to give feedback on the choices made. As design partners, children are considered equal partners in design during the entire process. Each of these roles requires different research methods to capture the children’s experiences.

If children are positioned as users, testers, or informers, many traditional usability evaluation methods can be adapted. For best results, they should be undertaken in a manner that acknowledges the qualities of child users. For example, the use of video recording may make children feel uncomfortable (Druin, 1999). This can be avoided by allowing children themselves operate the camera (Alborzi, Druin, Montemayor, Platner, Porteous, Sherman, et al., 2000). Using multiple cameras and their well-planned positioning can also help capturing observations better, since children may move in the environments in unpredictable ways. When conducting traditional usability testing, it

should be emphasized that it is the product, not the child that is being tested (Hanna, Ridsen, & Alexander 1997). A set of guidelines for laboratory-based usability testing with children has been suggested, concerning for example making the environment feel friendly and colourful and using shorter test sessions (ibid.). Using think-aloud method may be problematic, since children may find it difficult to verbalize comments during use. Active intervention, where the investigator ask planned question on certain points may hence be more useful (cf. van Kesteren, Bekker, Vermeeren, & Lloyd, 2003). Post-task interviews, where children describe their experiences after use may also provide challenges since it may be difficult for children to accurately recall past actions and keep several concept in memory at once. However, if combined with observation, post-task interviews may reveal as many problems as think-aloud (Baauw & Markopoulos, 2004).

In many cases, it may be beneficial to include more than one child in the testing session. Co-discovery (Dumas & Redish, 1993) and peer tutoring (Höysniemi, Hämäläinen, & Turkki, 2003) are methods in which the testing is done in pairs of children. In co-discovery there are two testers, who collaborate in trying to solve tasks using the technology. This way, communicating is more natural than in individual think-aloud. It may also be closer to children's natural patterns of behavior. However, the acquaintance of the pairs has a significant impact on the found problems (Benedikte et al., 2005). Children may also be unwilling to interact with each other (van Kesteren et al., 2003). The peer tutoring method builds on the notion, than when playing together, children regularly teach each other games and rules of play. In peer tutoring, a children with expertise on the technology teach other children to use it. These interactions are then observed and analyzed. However, to be effective peer tutoring requires a decent amount of time, training and planning (Höysniemi, Hämäläinen, & Turkki, 2003).

For children to be adapted as fully equal design partners in the technology design process, a systematic approach called cooperative inquiry has been introduced by Druin (1999). It combines features from participatory design, contextual inquiry, and technology immersion methods. In this approach children and adults work together as partners in a research team, with children constantly interacting with prototypes, devices or software during the design processes. Both the researchers and the children observe, take notes and interact with users. At least two notetakers and an interactor, who initiates discussions and asks questions from the users, are constantly present. Its is

important that either an adult or a child can fill these roles. Children should be included in the process from the start, also participating in the brainstorming and ideation phases. Possible issues to pay attention are to make sure that the children are provided appropriate tools to present themselves – instead of notetaking, children may prefer art supplies such as paper and crayons – and that the power structures of the traditional adult-child relationships do not steer interactions in the design process (Bruckman et al., 2012).

Which methods then are best for evaluating children's experiences? There have been comparative studies to evaluate the effectiveness of different methods (cf. Benedikte et al., 2005; Baauw & Markopoulos, 2004; van Kesteren et al., 2003). According to van Kesteren et al., methods that provide systematic procedures for prompting verbal feedback such as active interaction produced most usability issues found, while co-discovery produced least. However, collaborative work may prove very useful when involving children in the initial design phases. To benefit from the strengths of individual methods, multiple methods can be combined for most rigorous results. Obrist et al (2011) used this approach in their multi-method study of children's first hand user experiences. The phases of their user study included demographic questionnaire, free exploration and game behavior questionnaire, peer tutoring session, codiscovery session, game experience questionnaire and feedback cards session, and codesign session. According to the authors, the multi-method approach provided in-depth insights into the children's experiences as the data from different methods used supported each other. Furthermore, data from longitudinal behavior analytics, such as usage times can be combined with more ethnographic data, as conducted in the study by Dunwell et al. (2014).

In conclusion, there are many different methods and approaches to study children's user experiences that can be adapted to guide the design process. The appropriate methods should always be chosen depending on the studied product and the phase it is in development. Combining multiple approaches and data may also prove useful. Studying children's user experiences helps us understand their needs better and build more fun and useful products to support their learning and growth.

4 BUILDING, INTERVENTION, EVALUATION, LEARNING

This chapter presents the Building, Intervention and Evaluation and the Reflection and Learning phases in the development of the Pikin huone game. We first review how the principles of the ADR phases manifested in the design and development process. Reflecting the IT-dominant BIE process in ADR, we then first describe the production of the Alpha version, referred to here as the “first demo” which was produced as a proof-of-concept for the client organization. Following that, the Beta version, referred to as the “second demo” that was targeted for the actual end-users is presented.

4.1 ADR Principle 3: reciprocal shaping

In ADR, both the technological design choices made, and the surrounding organisational context are supposed to influence the design process (Sein et al., 2011). In this project, there were multiple organizations involved that influenced both the requirements and the outcome.

First of all, Tukes, as the original initiator and the funder of the project had their own requirements for the resulting game. The different facets of safety are addressed in Finland under different governmental organizations: the focus of Tukes is on chemical and materials safety and electricity, while there are other organizations that are responsible for example fire safety for. Therefore having Tukes as the orderer had a direct effect on what safety areas were to be emphasized in the game. Tukes gave feedback about the game during the different phases of the project, and had the ability to steer the design to support their requirements.

In the second demo phase of the process, Yle was brought in as another participating organization, who provided the publication platform for the game. This brought in a set of limitations for the technology choices and the content of the game, that are addressed when describing the second demo.

Finally, the project taking place under the coordination of the Demola organization had effect on multiple facets of the outcome. In order for the student to get study credits from the project a certain amount of working hours and comprehensive reporting had to be carried out. The schedules and resourcing for the project also gave from Demola. All Demola teams were also instructed and encouraged to use certain methodologies and tools in their projects such as the Lean service design framework, personas, interviews and paper prototyping.

4.2 ADR Principle 4: mutually influential roles

ADR emphasizes mutual learning between the persons that participate in the project under different roles (Sein et al., 2011). The Tukes representatives brought in expertise in safety awareness and how to present the knowledge to the public. The Yle representatives on the other hand provided the team their extensive experience on the technological and practical matters in children's game production. The project team implementing the game was itself a highly multi-disciplinary ensemble: during the two phases of development the team included students majoring in computer science, human-technology-interaction, graphic design, safety engineering and interactive media. During the whole project, there was a continuing transfer of skills and knowledge ongoing due to the project's collaborative nature.

4.3 ADR Principle 5: authentic and concurrent evaluation

ADR emphasizes the concurrent execution of the building, intervention and evaluation steps (Sein et al., 2011). The developed game was evaluated along the process by many different stakeholders. During the first demo development, the nature of evaluation was formative, primarily seeking the potential ideas in the demo for further development. The first demo was evaluated thoroughly by a children's interaction design expert, and a survey was conducted to a group of university students in interactive media with extensive knowledge on games. Similar to the schema for an IT-dominant BIE process, no extensive tests with authentic users were done at this point - only three actual players being of target group age were observed playing the game.

For the second demo phase, playtesting with actual users was prioritized. Playtesting with co-discovery and observation methods adapted from the literature was conducted at four dates in two regional kindergartens, and the designs were iterated based on the emerged issues. Additionally, another survey was sent out for the interactive media students group. The nature of evaluation at this point was more summative, assessing if the included safety content were understandable to players.

In addition to the controlled evaluations, feedback was thoroughly asked throughout the project from peer students, Demola facilitators, and the teachers of the participating kindergartens.

4.4 ADR Principle 6: guided emergence

In an ADR project, the developed artifact should be formed not only based on the preliminary designs, but by the ongoing shaping by organizational use, perspectives and participants (Sein et al., 2011). Hence, the designers should pay close attention to the signals stemming from the contextual factors, that indicate emergent refinement of the concept. The concurrent evaluation discussed above brought both substantial and minor changes to the game - the first demo was developed based on a linear storytelling narrative with different mini-games included in certain scenes. Based on the evaluation of the first demo this was not seen as a good approach regarding the persuasiveness of the content and replayability, so the second demo was structured rather as a collection of instantly playable mini-games. In the second demo BIE cycle, the playtesting brought out mostly usability-related issues, which were then addressed in the iterations. The changes in the project organization, such as new project team members joining and Yle joining as a participant organization also caused emergent change to the final version. The suggested process model and design principles presented as the outcome of this thesis also emerged from reflecting and learning from the process.

4.5 Alpha Version

4.5.1 First demo development

The first development phase began with a first meeting to form the organization for the duration the development, including the Demola facilitators, the representatives of

Tukes, and the project team of students. The participants got to know each other and were briefed on what Tukes wanted to achieve with the project. Preliminary scheduling and agreement on the outcomes of the project were accomplished. It was decided that, similar to the the IT-dominant BIE-process, the first phase of development would provide a playable demo version of an interactive game with the required safety contents. The student team were also provided materials to study what safety-related matters could potentially be included in the game.

To apply user-centered practices on the early phase of the design process, the project team conducted a number of field interviews of parent of preschool age children. Six interviews in total were made, from which four were made at a local playground and a multiplex theatre, while two were phone interviews of parents of small children. The interviewed parents had 2-7 year old children, with average age of 4,11. A semi-structured interview was conducted with the following questions:

- Where do your children pick up safe behaviors?
- Do you think kids learn safety from a digital game?
- What devices do your kids use for playing games?
- What kind of games do your children play?
- Are you familiar with the Pikku Kakkonen games?

According to the interviews, the parents saw that children get their safety awareness from kindergarten, older siblings, children's TV programs, or from the parents themselves. None of the interviewed parents independently mentioned video games as possible source of safety advice. However when asked, all of the parent agreed that they thought children could also learn about safety through games. 33% of the parents informed their children used computer to play the games, while table was in use in 83% of the families. Only one parent told their children used a mobile phone for playing. Mentioned game genres included action, learning, construction, dress-up, and memory games. Some parents noted that if game feels too "educational", children will think it is boring. Four of the six interviewed parent were familiar with the Pikku Kakkonen platform, which is a service provided by the national broadcasting company Yle to provide browser-based and mobile games.

The project team then proceeded to the ideation phase to decide upon the contents the first demo would deliver. One of the foremost decisions was to define the target age for the game: children in different developmental phases differ in their cognitive and motoric capabilities. It was decided upon that as the game would mainly target kindergarten-aged children from two to six-year olds. Although there can be a big difference in skills between a two and a six-year old, as well as among cohorts, it was thought the game could be accessible to both ends of the spectrum.

Another thing to decide was the safety context that the game would handle. The project team researched potential dangers children encounter in Finland, coming up with a list of topics that included for example traffic safety, drowning prevention, fall prevention, poisoning prevention, burn prevention and choking or strangulation prevention. It was suggested if the game would have some sort of a safety evaluation meter that would detect how safe the player's actions would be in a given moment in the game environment. The game was planned to include environments familiar to the children, such as a kitchen, a playground, a skating rink or a swimming hall. This way to players would be easily to be able to reflect to game into their everyday lives.

The possible characters and theme were collectively brainstormed, resulting in a consensus that the characters should preferably be humanlike, although not necessarily human. It was suggested if the game depicted a same character in different ages, or a family of characters to be able to position them in different situations and environments. In the end, the project team came up with an idea of an alien family on Earth who are not familiar with the necessary safety precautions, and whom the player would have to help act safely. This way, the players would act as the ones providing the safety knowledge to the characters, potentially making them feel more confident and reflect on their own safety awareness.

As the fundamentals of the characters and story were set in place, the project team started designing the game structure further. The design methods used included iterating on physical low-fidelity prototypes and scenario-based sketching of the different phases of the gameplay. The focus at this point was more on the story and the possible environments than actual game mechanics. The outcomes of this design phase were drawn as storyboards of the game structure (see Figure 5).



Figure 5. Story boards for the first demo.

At this point, the technical requirements and technology decisions were also discussed. As the interviews of the parents revealed that their children used a variable set of devices to play games, the game would have to be accessible from multiple platforms, such as different brands of mobile devices and web browsers. It was then quickly decided that the game would be implemented as a multi-platform HTML5 game. An open source game development framework called Phaser.js for the JavaScript programming language was selected as the development platform, providing a support for Canvas and WebGL browser technologies. It was also marked that as many of the families already used the Pikku Kakkonen platform to play games, possibly co-operation with Yle would provide a ready-set user base to reach a high amount of users.

The design decisions so far were presented to Tukes to gather feedback. They thought the idea was fresh and that the basic concept would give a lot of opportunities. Being accessible through a mobile platform was held as a key point. Focusing on the age group of 2 to 6 olds seemed appropriate at first and it was also thought possible to extend to other user segments later as well. Tukes also emphasized that they did not

want to be explicitly to be marketed as being behind the game, as it would have to stand on its own. Possible co-operation with Yle was believed to be a good idea.

As the plans were accepted, the project team went on to develop the first playable demo of the game. The game was based around a linear story, where the character would proceed from one scene to the next. Sometimes there would be precautions that would need to be done, such as putting a helmet on before going cycling, and occasionally there would be replayable mini-games included in the scene. The following contents were included:

- The main menu, from which there were buttons to play the stories of four different game characters, and a possibility to watch the introduction.
- The introduction animation, which introduced the characters and the basic story of the games: the four friendly aliens landed on Earth and moved to a house in a normal-looking neighbourhood.
- A possibility of playing the story of one character. In this story, the player has to guide an alien through a bicycle drive to a local playground to meet his friend on a trampoline.
- A non-interactive draft of a packing situation, where the player would have to choose from their belongings the safe items to take with to a bike trip (see Figure 6).
- An interactive mini game, where the player has to pick up vegetables popping out from the ground with whack-a-mole type of game play.
- When leaving the house, the player would have to first pick a helmet from a tree branch to be able to proceed into the bike riding section (see Figure 7).
- The bike riding section, where the player would have keep a watch on the rock on the sides of the road to keep on moving by pressing arrow buttons on the side. Otherwise the player would stop moving.
- A non-interactive draft of a mini game, where the player would have to collect ice cream from an ice cream machine.

- A scene at the playground, where the player meets the friend at the playground. The friend is jumping on the trampoline. When the player tries to join him, the friend announces that only one person can jump at a time (see Figure 8).
- A trampoline game, where the player collects fruits that appear above him by jumping on the trampoline, until the fruit meter becomes full.
- The demo ends when the player leaves the playground to watch kites being flown.



Figure 6. Packing the needed the safety equipment.



Figure 7. Wearing a helmet before going cycling.



Figure 8. Waiting for a turn at the trampoline.

The implemented instances of procedural rhetoric in the first demo and the persuasive purposes behind them are summarized in Table 1.

Table 1. Procedural rhetoric in the first demo

Persuasive Purpose	Instance of Procedural Rhetoric
Being prepared with the right items related to safety before going out.	Choosing necessary precautionary items is required before player can leave the house (see Figure 6).
Wearing a helmet while biking.	The player must put the helmet on before they can access the bike (see Figure 7).
Only one person can use a trampoline at a time. An adult must supervise jumping on a trampoline.	A cutscene is shown before a trampoline jumping game, where a boy character tells to wait your turn. An adult supervisor is present (see Figure 8).

The playtesting of the project at this phase was by asking feedback about the different sections of the game from peer students along the development and having two target-group aged children play the game from start to finish. It was observed that both children were able to complete the game from start to finish, and understand the interaction methods in different section. Also one member of the project team with a child that was in the target age had the child play through the game to observe potential usability issues. In retrospective, the playtesting that was conducted at this phase was not sufficient to get enough information about the persuasiveness and overall playability of the game. The reasoning for the low priority of user testing was that the first demo was planned to be more of a proof of concept for the customer organization rather than a real product targeted to customers.

A lecturer from a local university with research background in children’s technology design was asked to evaluate the first demo and give suggestions on future improvements. One of the themes that rose up in the evaluation was the replayability of the game should be considered more: the concept of having different mini-games as a way to distribute the content was seen as a good idea. In the evaluation the topic of measuring the persuasiveness of the game also came up: the evaluator emphasized that

it would be important to test both the game interface and the educational side, and measuring that the persuasive message was understood by the users.

4.5.2 First demo evaluation survey

Further feedback on the first demo was acquired via a survey to a group of university students with extensive knowledge on game studies and interactive media. A total of 9 answers were collected from respondents, 44% of being male, 56% female. The respondents were asked to evaluate both the look and feel of the game, as well as the persuasiveness of the safety content.

The respondents gave mainly positive feedback about the graphics, appearance and the rhythm of the game:

- *“The appearance is suitable for children”*
- *“Separate, white-framed objects that can be interacted with is a big plus considering that many children might have perceptual problems or slow visual processing skills!”*
- *“The color palette is appropriately colorful especially for small children and the characters look fun”*
- *“The pace and rhythm is especially good for younger children.”*

However, some respondents found it difficult to understand what items in the game are interactive and how to progress within the game. This was partly due to the tested demo still having incomplete, non-playable segments.

- *“Maybe there will be more story/instructions. Now it’s a bit difficult to know what to do”*
- *“It was not very clear what elements in the game were clickable (unless being clearly made as buttons). You had to click around to know where to press.”*

It was also considered a defect that the music could not be silenced and some interactions were considered inconvenient:

- *“Could there be a controller for the background music? Too loud or continuous auditory stimuli can complicate concentrating on other contents.”*
- *“[In the biking segment] you have to tap instead of pressing... Nowadays tablet users would rather slide their fingers around”*

In general, the respondents didn't think the connection between the game contents and the safety theme was clear enough:

- *“I for one didn't really see the connection between the events and safety. There were some safety related items for example in the backpack, but they didn't seem to have anything to do with the game.”*
- *“The first mission I did was the carrot game, and afterwards I had to read the [instruction] e-mail again, was the game about healthy life habits or safety”*
- *“Many actions such as picking fruits and vegetables had nothing to do with safety”*
- *“Safety was addressed in the form of a first-aid kit and a safety vest found in the backpack, but you could not pick it up. You got to wear a helmet when you went biking, but nothing happened when hitting a rock”*
- *“In the playground, only the trampoline was somehow connected to safety. I didn't understand the fruit collecting mini game. Especially when the flying bee didn't have any effect.”*

However, there were also some positive comments about the safety contents. Especially using the mini-games for presenting different safety information was considered to have potential:

- *“The minigames are really good, simple to use and quick to learn and function as a small reward! Especially the game by the trampoline is really good, as there is a direct connection to the pedagogical content (‘wait for your turn, only one jumper at a time’) and then the game is activated.”*
- *“I believe the game help children pay attention to safety, for example putting a helmet on and waiting for your own turn, etc. Transition to mini-games through*

insightful sections (helmet on before biking, safety belt on before riding a car, looking both ways before crossing the road, etc) help children focus on the game's message"

- *"The parts that provided enlightenment were made nicely: They didn't pop out, but were still there"*

4.5.3 Summary of the first demo phase

Based on the evaluations, the audiovisual quality of the first demo was thought to be distinctive and characters were seen to be appealing to children. The pace, rhythm and interactions were also seen as suitable for the target group and the few children that tested the game were able to proceed within the story. However the linear, narrative-based game structure did not seem to support the idea of persuasive learning. The safety-related contents were seen to be too hidden among other contents, and many of the survey respondent told they did not really understand the connection between the game and the safety themes.

Despite its shortcomings, some parts of the first were seen to have potential for further developments. The mechanic of having to put the helmet on or pick up protective items before being able to progress to the next scene was seen as a very practical way to make the player reflect the necessary safety precautions to everyday situations. The concept of mini-games were also seen as a very viable way to increase replayability. However each mini-game included should connect at least in some way to a certain safety issue.

The initial idea of targeting 2- to 6-year-old children was also in retrospective considered unlikely to succeed. Small children develop fast, and there would have been too big a gap between the understanding and the motoric and verbal skills at the both ends of the spectrum. For the second demo, a refined target of 3- to 6-year-olds was set.

During the final meeting of this phase with Tukes, they seemed content with the demo - the audiovisual quality was high, and having a responsive web-based HTML5 application as the technological platform was seen as flexible and easily extendable, and it would provided the content to be available on most different platform from desktop computers to touch-screen mobile phones and tablets. Tukes were hence willing to proceed with developing the demo into a refined version for end-users.

4.6 Beta Version

4.6.1 Second demo development

The second demo development took place in the fall semester of the same year. The biggest change in the organizational surroundings was that as the Finnish broadcasting company Yle joined as a stakeholder that would provide publication platform for the game. The platform was the biggest children's game service in Finland, service around 300,000 visitors per month and up to 100,000 visitors weekly. Therefore the purpose of the second development phase was to produce a high-quality playable product based on the earlier proof-of-concept demo.

In the initial meeting Tukes stated that they had no particular wish on the surroundings the game would take place, but some sort of dynamic environment such as a playground or a playroom could be a good starting point. The concept of mini-games was preferred over a story-based game. The focus was to still remain in general safety in children's lives. As Tukes wanted to reach new audiences and collaborate more with their current partners, they wanted the game to be extendable to different contexts in related fields such as fire and electricity safety, that were not directly under their jurisdiction. This way they could partner up with other organizations in the future to share the costs for future developments. One singular comment was that the safety content should be visible in the game, not "hidden" inside other game content.

Yle joining the project also brought its own limitations and requirements to the development. Yle wanted the game to focus on clear goals, such as individual mini-games, which was in line with Tukes' requirements. Yle had previously had games done with their own tool for interactive storytelling, but it was not suited for creating complex interactions. Therefore adding new, more "game-like" content to the platform had to be always done separately, which increased potential bugs. Another issue was their platform had been developed with Adobe Flash, which had priorly been the de facto solution for browser-based games but was now getting obsolete as companies such as Apple had dropped to support for it in their devices. Luckily, their platform supported embedding external content that was made with HTML5, which allowed the project team to continue the development with the previously chosen technology. Yle also had their own internal guidelines for all the content in the platform: the games

should not have any time-limits, scores or competition. Finally, concerning the themes and surroundings of the game, Yle suggested using fantastical environments such as underwater worlds and the space, similar to what they use in their own TV programs.

The project team started to work on the new version by having multiple brainstorming sessions. The team went over again the most common accidents among the target age group and ways to prevent them. One of the key ideas at this point was that the player would be given a chance to see the negative outcomes of a bad safety behavior in order to understand the causation and to be nudged for better decisions. Since the target player group included very small children, it would not be possible to show any shocking scenes resulting from bad safety precautions. Still, it should be possible to differentiate between the right and wrong behaviors - the game could be played in an inappropriate way, but the correct way to play should be clearly indicated. The project team brainstormed ideas until there were a couple ones that were considered viable. The game was decided to consist of mini-games, each tackling one core safety precaution for a risk that children would potentially face in their daily lives. During these design sessions, the project team used multiple service design methods such as personas and paper prototyping to help refine the safety concepts into game ideas.

The main idea behind the second demo was that, as before, a group of aliens had landed on planet Earth without knowing how to behave safely in everyday situations. The main character of the game would be a blue-coloured alien called Piki. In its final form, the game consists of three mini-games, each of which tackles one situation where safe behavior is required: eating, cycling, and sailing. Upon opening, the game presents a view with the character inside a room, from where the player can navigate to different mini-games by clicking on certain objects in the room (see Figure 9).



Figure 9. The opening screen of the game.

The first mini-game that was developed was centered around not eating dangerous or unknown items. One of the most common accidents happen to children is that they eat something inappropriate. Hazardous objects that may end up in the children's mouths include medicines, poisonous liquids, plants, tobacco, and different kinds of small or sharp objects. These were taken in mind when planning the mini-game. One purpose of the game mechanics was also to teach children not to touch objects they are not familiar with.



Figure 10. The eating game.

In the eating mini-game the player feeds the alien by clicking or tapping objects that are being rolled on the table, which upon touch jump into his mouth (see Figure 10). On the table there are non-eatable objects alongside the eatables, so the player has to make an active decision which objects are suitable for eating. Besides food items the objects include unknown packages with warning labels, screws and worms. There is no visible score meter, but the game keeps a score, in which every eatable object grants a point and feeding non-eatable objects decreases a point. The game ends with success when a total score of 7 is reached.

Another major safety issue the project team wanted to tackle was traffic behavior, since small children are sure to face many dangers in traffic in their lives. Similar to the section in the first demo, the character would have to put on safe equipment before going bicycling and keep aware of other traffic and obstacles. Following Yle's notions on using fantastic environments, the bike riding mini-game was decided to be located on space to make it more visually appealing and interesting. The meteorites and space ships would represent cars and other moving objects in traffic.



Figure 11. Dressing up for the space game.

The bike riding mini-game happens in two sections. In the first part player must dress the alien appropriately. The player is given three objects at once, one of which is the right, safe object to wear – either a reflector vest, a helmet or a reflector (see Figure 11). The player must drag the right object over the alien, which triggers the alien to wear the object and the next items come up. Once the player has picked up all three correct items, the game progresses to the next part, where the character bike-rides over a space scenery (see Figure 12). Clicking or tapping the screen activates the bicycle's thrusters, lifting the character upwards. The player must collect reflectors of different sorts, floating in space. Collecting reflectors increases the score bar and the game ends when the score bar becomes full. There are also meteorites and space ships crossing, which the player must avoid. Failing to avoid them only results in sound feedback, the score is not reduced.

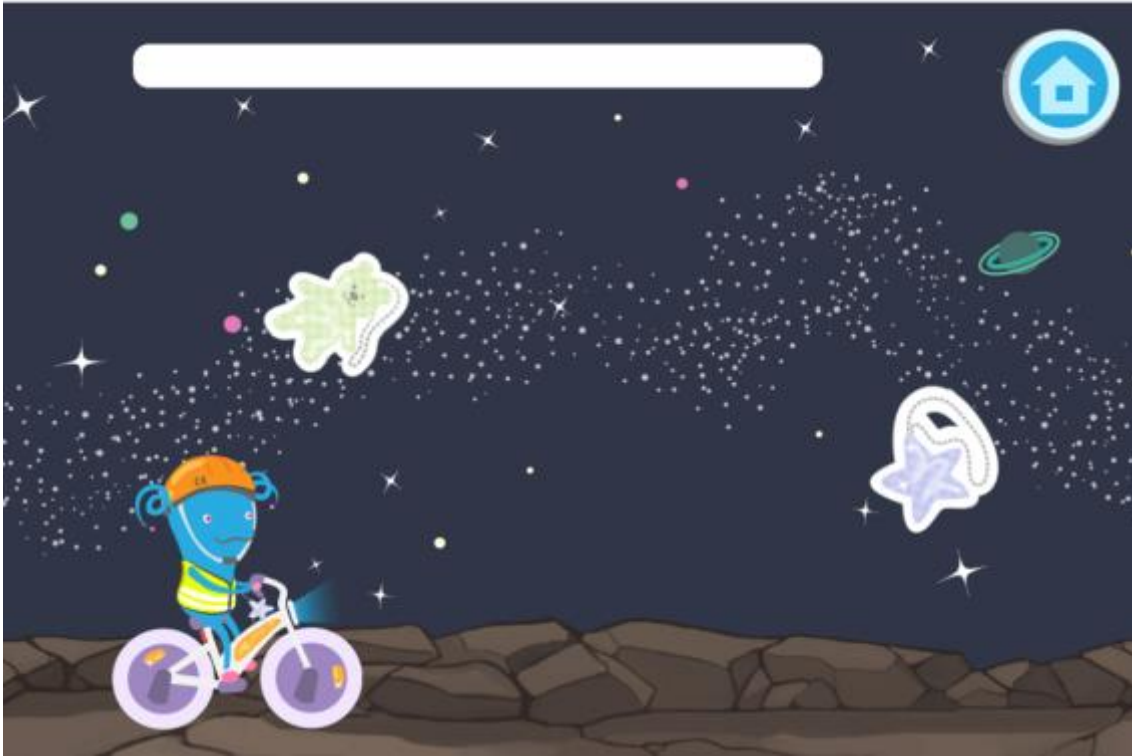


Figure 12. Cycling in the space game.

In the third mini-game developed, the idea was, similarly to the biking game, to make the necessary safety precautions before going sailing. It is quite common in Finland for people to go sailing or boating with their children, and learning to wear a lifejacket properly in the early age is important. In the lifejacket game Piki's friends are going for sailing, and the player must dress them with correct sized lifejackets (see Figure 13). There are three different-sized aliens and three life jackets which must match the corresponding alien's body shape. After dressing the aliens the player also must fasten the belts of the lifejackets by clicking or tapping on them. Completing these two steps makes each alien walk to the boat. After all three aliens are properly equipped, an animation with them on a boat follows. The idea was to continue to mini-game with an additional part, where the player would learn the use of a lifesaver. However, there was not enough time to develop this idea further at this time.



Figure 13. The life jacket game.

Other potential but not implemented game ideas concerned fire safety and electricity safety skills. The implemented instances of procedural rhetoric in the second demo and their persuasive purposes are presented in Table 2.

Table 2. Procedural rhetoric in the second demo

Persuasive Purpose	Instance of Procedural Rhetoric
Children should not put non-edible things in their mouth.	In the eating game, the the player has to tap away the non-edible items, before the characters eats them and feels sick (see Figure 10).
Before going biking, children should wear a protective helmet and safety vest and a reflector.	The player must sequentially choose the safe item from a row of three appearing items before being able to continue to the next scene (see Figure 11).
When biking, children should be aware of passing obstacles and cars.	The player must avoid passing asteroid and spaceships while collecting reflectors on the bike (see Figure 12).
Before entering a boat, children should wear a proper-sized and properly fastened life jacket.	The player must choose a fitting life jacket for each of the three characters and fasten their belts (see Figure 13).

4.6.2 Second demo playtesting

During the development of the second the demo the project group wanted utilize more the practices of UCD process and involve actual users more in the design. Two kindergartens (referred to from now on as Kindergarten 1 and Kindergarten 2) in the Tampere area were contacted about organizing playtesting sessions with groups of target-age children. The participating children were three to five years old. Four different sessions were held at the two locations with a varying number of test moderators. Co-discovery method (Dumas & Redish, 1993) with a pair of children playing the game together was used in most of the sessions (see Figure 14 for a demonstration of a playtesting session). As suggested by Hanna et al. (1997), the sessions were short and situated in a colorful and familiar environment in the kindergarten. Observation, active intervention and post-task interviews (van Kesteren et

al., 2003; Baauw & Markopoulos, 2004) were used to gather results. Playtesting sessions were held during two different phases of the development and the designs were iterated based on gathered observations. In addition to the playtesting, the kindergarten teachers were interviewed about their opinions of the game and safety education in general.



Figure 14. Setup for a playtesting session.

First round of playtesting

The first testing session was held at Kindergarten 1 with one person doing both moderation and observation. At this point the tested version of the game included only the eating mini-game and an early version of the space-themed mini-game, where the character tried to grab reflectors by jumping. The playtesting was conducted with six participating children in pairs, aged from four to five. Only one of the players had previous experience about tablet-based games.

Based on the observations from the sessions, the eating game was very intuitive to the children and they understood the idea behind it: what you should eat and what not. However it turned out that more negative feedback should have been given from eating the

bad things, since the good and bad reactions were not easily distinguishable. In the space game the players did not recognize what the reflectors were, but mistook them for example toys. The reflectors were also tried to be tapped, as they were visually very similar to the items in the eating game. The mechanics of filling the “energy bar” from picking reflectors was understood. When asked, the players thought the visuals and overall feel were described fun. The eating game was overall liked more.

The second testing session with the same version of the game was held at Kindergarten 2 with 12 children participating and two persons moderating and observing the test. Players were four to five years old and one three-year-old and had varying experience on playing games with a tablet. Also in this group the eating game seemed to be the favorite for most of the children. The players understood what things are eatable and what not, and some considered it fun to purposefully feed the character wrong things. The players also understood the mechanics of the space jumping mini-game and liked making the alien jump around, but only one player was able to recognize the items as reflectors in the space game.

The tested mini-games seemed easy for 5-year-olds, especially if they had played with a tablet before: some of them even said that game was too easy. For the 3-year-old the game seemed to be more challenging than for the others. She needed guidance to understand what she was supposed to do in the game, especially the eating game. She didn't seem to understand that the alien is supposed to eat the items. The space game was easier to her, she only had little trouble understanding the coordination of the arrows and tried to play only using the left and right arrows.

Design iteration after the first round of playtesting

Based on the observations from the first round of playtesting, multiple improvements were made to the second demo. The feedback from eating good or bad was made more explicit: the animations and the character's impressions were made more lively and caricature-like to reflect whether the eaten item was right or wrong. Attention was also paid to the speed of the foods appearing.

The space game went through a more radical change. After playtesting it was understood that the current implementation, which was just a reinterpretation of the trampoline game from the first demo with changed graphics, did not really present any

persuasive content that would connect with the player's life – they did not even recognize the items as reflectors. The mechanics were changed to resemble a side-scroller game and adding incoming cars and the dress-up section made the role of the reflectors more explicit. An advisory instruction screen was added before the start of the biking section.

As the graphics, overall feel, controls, sounds and music were seemingly liked by the players, no big changes were made to them. The dress-up section of the bicycle mini-game was also added as a new feature for the second test in Kindergarten 1, and in addition to that, the lifejacket mini-game was added for the second test in Kindergarten 2.

Second round of playtesting

In the second session in Kindergarten 1, 12 children participated to the test, some of which had already played the earlier version of the game in the previous session. The participants were one pair of 3-year-olds, one pair of 4-year-olds and 4 pairs of 5-year-olds.

The dressing up section was generally understood but had some usability issues. One pair were able to choose the reflector vest as their first choice but they did not succeed to dress them on the character even though they placed the vest on top of the him. However, another pair was not able to dress up the alien, but instead just tried to click the objects instead of dragging them. Two of the pairs did not identify or understand the concept of a safety vest. Helmet was recognized by all of the pairs, but some mistook the reflector for jewellery. While some players had trouble understanding the the items could be dragged and choosing the proper items, all of the pairs were in the end able by trial and error complete the dress-up section.

In the biking section of the space game, most of the participants started interacting with the game by trying to tap the alien. Some also tried tapping the floating reflectors. Generally it took some time for the players to notice that clicking anywhere in the screen made the character thrust upwards. Also a bug that was discovered during the testing that the players could make the character disappear over the top of the screen by rapidly tapping the screen, which caused confusion to some players. This also resulted

in some unexpected emergent gameplay when pair of 5-year-olds thought it was funny to repeatedly make the character go all the way up above the screen then then fall down.

The eating mini-game was easily understood by most players. Only one pair of 4-year-olds were not able to understand how to play it without advice: they clicked immediately on every appearing item instead of letting the objects move first closer towards the character. The pair of three-year-olds also needed some leading to understand the goal. The difference between good and bad foods were clearly understandable, and many pairs found it funny to purposely feed the character wrong foods to see his reaction. One pair of 5-year-olds even found feeding wrong foods so funny that they were not able to finish the game. Eating game was mentioned as the favorite one by most of the players.

After the session the testing team reflected that possibly some of the questions they made and advices given were possibly too leading: for example the moderator told on occasions that the players need to dress up the alien before they started playing. However for some of the children it was necessary to prompt them a little bit to make them proceed in the game. Some of the children already had played the games with before so everyone was not at the same level of experience. Also, since after the first pair there were three person from the project team present, which possibly made some children nervous. At Kindergarten 2 there had been a teacher present almost all the time which may have made the children feel more relaxed.

The final testing session was again held at Kindergarten 2 with one moderator and two observers attending and a total of 15 4- to 5-year-olds participating. The agenda behind the testing was mostly to test out the newly-added life-jacket mini-game, the testing of other areas of the game was mostly confirmatory and revealed few new observations. One new usability issue that came up was that as we now had two mini-games that relied on the interaction of sliding a finger across the the pad, in some cases doing this brought down the operating system menu on the test device, which interrupted the gameplay. It was also quite common that when a new section or scene opened in the game, the players were uncertain when to start interacting with the game without being prompted.

In the lifejacket mini-game, the correspondence between the size of the characters and their matching lifejackets were generally understood well by the players. They were

able to find the right lifejacket and drag it on the character. The similarity between the dress-up section and the lifejacket game clearly made understand the mechanics easier when playing the one before the other. Lifejackets were also more familiar to the children than the safety vests in the space game. Some players needed advice on fastening the lifejacket belt after the finding the right one, as it was not indicated clearly enough how to proceed.

One observation from both the second test sessions was the the sound effects worked and were liked by the players - they laughed at the character's responses, understood their meaning, and wanted to play the game again to hear the sounds.

Design iteration after the second round of playtesting

The second round of playtesting unearthed a set of quite easily fixable usability issues: refining the object hitboxes, preventing the character from escaping the screen limits, minor adjustments on the responsiveness of the controls. These were addressed when iterating the game to its production-ready version. Small tweaking was made to the sound effects: one sound effect that sounded like laughing that was heard when colliding with an object in the space biking game was removed as it gave a conflicting impression.

A more prominent issue that was observed was that it was difficult to players to understand when and how to start interacting with the game when a new scene appeared: they needed subtle guidance from the test moderator to start experimenting. The project team decided to address this by including voice narration the the beginning of the mini-games, which would give a short instruction on how to play. The narration also emphasized making the situation safer, making the persuasive intent more explicit. As Yle's resources were available, a voice actor known from the children's TV programmes was asked to provide the narration segments. This clearly made the game easier to approach and start playing by the novice players. In some sections the interactions with the game affordances were also highlighted more with visual cues: in the lifejacket belt fastening segment, the belt was marked with a white expanding circle to draw to player's attention.

4.6.3 Second demo evaluation survey

As well as the first demo, the second demo was evaluated by a group of university students with extensive knowledge in games and interactive media. The evaluators were asked 1) to give feedback about general aspects of the game (graphics, sounds, overall playability) and 2) evaluate how the game would succeed in increasing small children's safety awareness. A total of 8 persons answered the survey.

The look & feel gathered mostly positive feedback from the participants. The characters, graphics, sounds and playability were in general considered good:

- *“The characters look fun. Colors are nicely diverse and appropriate for children. Clicking things is simple enough for small players”*
- *“Graphics are nice, playful and colorful. The audio speech is sometimes muffled a bit, but overall it is clear. Music also adds a special feeling to the game.”*
- *“The sounds are good and the background music is easygoing enough not to be a hindrance for concentration”*
- *“Game mechanics are nice and simple.”*
- *“Feedback is immediate (the sounds)”*

The few negative remarks concerned minor flaws in game balance and mechanics:

- *“The life vest mission is relatively short compared to others”*
- *“The flappy bike was way too long in comparison to other content”*
- *“The meteors in the space portion are impossible to dodge since the player character takes up half of the screen height and most of the meteors reside in the middle of the screen”*
- *“The food part was maybe a bit too slow?”*
- *“Maybe a bit more challenge, more levels etc?”*
- *“Eating different things did not end and got boring although the character had eaten even the non-eatables”*

Also regarding the persuasiveness of the safety content, there were clearly improvements compared to the first demo. Especially connecting the safety content to the real world issues was considered a positive:

- *“Big plus about the CE-marked helmet (the markings are made a part of an easily accessed information about real life; they exist and should be adhered to and that shows in the game)”*
- *“[The game has] real content, such as exclamation points and poison indicator (see CE-marked helmet)”*
- *“Especially the parts where the characters were dressed up were very informative, and a small child will easily notice what kind of equipment is needed when going sailing or biking”*
- *“In the given safety protocol areas that the game covers, it succeeds very well. Its appearance is fascinating and easy to perceive and the white halo around the objects that can be interacted with makes the experience effortless, so that the main stress is on the safety content. It is suitable for the age group and deals with important issues of the given target audience.”*
- *“Seems like it covers the most important topics a child of that age would need to know.”*

In one comment it was seen that additional discussion about safety precautions would be needed in addition to playing the game, but the game would provide a good starting point for discussion:

- *“This is good game. For smaller children, some additional guidance is probably needed but I guess that's necessary anyway (“You need to wear the helmet because.... This safety jacket is a must for everyone when going far from the shore...”) But this game provides nice opportunity to discuss these issues.”*

A single critical comment was given about being able to eat the dangerous items in the eating game:

- *“Even if you fed the character lego bricks, screws and washing powders, he kept munching happily. There could be more radical consequences, but it’s an alien, so what do you know”*

4.6.4 Summary of the second demo phase

The playtesting sessions in the kindergartens demonstrated that the target group players were able to understand the safety content of the game presented via its procedural rhetoric. The feedback from the evaluators seems to support this assumption. Assessing whether the children understood the purpose of the game during the testing was somewhat challenging, since it was difficult for most of the players to test verbalise themselves during or after the playing situation, when directly asked what they had learned. However, the players seemed to understand what to do in the minigames and their conversations during playing showed that they understood what kind of behavior was desired in the game. When asked further questions about the safety themes like “Why do you need to wear a reflector when it is dark outside?”, most were able to answer correctly.

The players were also able to connect the safety issues presented in the game with their own life: one boy for example started telling about a boat trip he had had with his family while playing the lifejacket game. Including unobtrusive real-life safety information in the game, like the Conformité Européenne (CE) markings and warning signs in the packages may also support in paying attention to these issues in everyday life. In addition, a kindergarten teacher informed the project group that the children seemed to feel enthusiastic towards the game and even kept on talking about it after the test sessions. However, since the playtesting sessions were only individual events and no follow-up interviews were conducted, it no definite conclusions about the long-term effects of the game on the children’s safety awareness can be drawn at this point.

Making a game for this certain age group was challenging, because small children develop very fast: there is already remarkable difference in skills and understanding between a 3-year-old and a 5-year-old. However, the game seemed to appeal to the age group very well. Although the youngest players seemed to find the game quite challenging, and some of the oldest players thought it was easy to play, all of them seemed to enjoy it regardless. Most of the children wanted to play the minigames again

and some of them said that they would also play the game at home if they could - one player even told that the game had become her favorite game.

The audiovisual quality was a key point in making the game succeed. The graphics and the sounds are the qualities that engage users and motivate them to play the game. According to both the playtesting and the feedback survey, the project group was able to produce a game with distinctive audiovisual quality.

Finally, it was considered as one of the main features of the second demo that it would be easy to expand upon for future developments. The non-linearity of the game allows new mini-games to be easily added to the game platform. The mini-games structure also increases replayability and allows children to focus on the sections of the game they like the most.

5 LEARNING OUTCOMES

This chapter presents on the outcomes that were derived from the reflection and learning of the BIE cycles.

5.1 ADR Principle 7: Generalized Outcomes

Sein et al. (2011) mention that generalizing the outcomes from an ADR project is challenging, since they encompass the organizational change and the implemented artifact in a highly situated manner. In order to generalize the solution that addresses a certain problem, they propose a three-level process: 1) generalization of the problem instance, 2) generalization of the solution instance, and 3) derivation of design principles.

Our ADR project addressed the problem of designing a persuasive game for children in the context of safety awareness. However, there is clearly potential for using persuasive game solutions also in other instances such as adopting healthy lifestyle or sustainable environmental behaviors. Our solution was carried out through an iterative process of designing and implementing a solution and evaluating it with playtesting and expert evaluation. There is potential here for generalizing this process of game production - hence we present below a general process model for persuasive game design, derived from the reflection and learning from the BIE cycles. The process model is presented as generalizable for all persuasive games, not just children's games, as the UCD methods adapted for children used in our project can be easily replaced with other methods suitable for different user groups. In addition, a set of design principles for designing a persuasive games especially for children is presented based on the experiences during the design process.

5.2 Process Model for Persuasive Game Design

Based on the experiences from the development process of Pikin huone and the priorly introduced human-centric design process ISO 9241-210:2010 and the iterative process for playcentric design (Fullerton, 2008), we present that after the problem that the persuasive game needs to address is identified, the following iterative process of 1)

understanding and specifying the persuasion context, 2) generate instances of procedural rhetoric, 3) playtesting with users, 4) evaluating results with appropriate metrics should be carried out, resulting in a game version that addresses the identified problem. The model positions the theoretical concept of procedural rhetoric as an integral part of a user-centered design process for persuasive games.

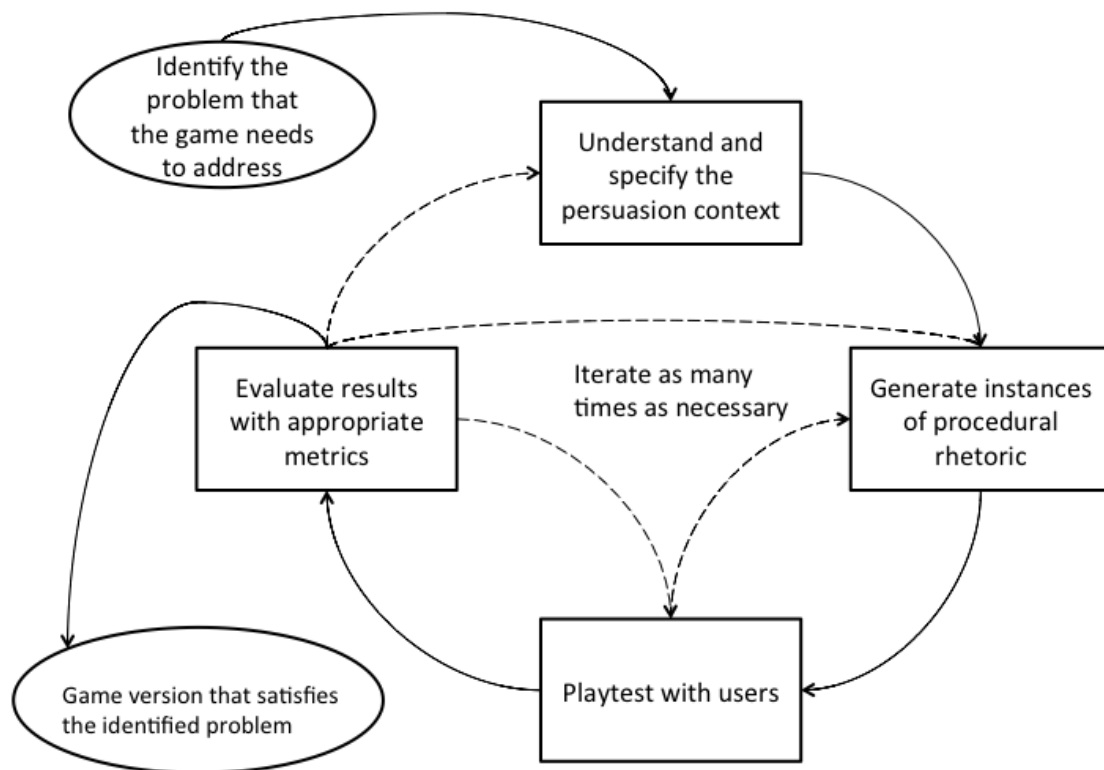


Figure 15. Process model for persuasive game design.

Understand and specify the persuasion context phase should include the use of user research methods such as contextual inquiry, focus groups, interviews and personas to specify the need for the persuasive intervention. Getting in contact with end-users already in this phase ensures that the actual users needs are addressed in the development. In our project this phase included interviewing parent of the users about safety matters they thought were important, as well as researching the statistics for common safety issues for children.

Generate instances of procedural rhetoric phase should formalize the identified persuasion needs into game ideas, which are the refined into actual game mechanics. A set of brainstorming and game ideation methods can be used to generate ideas, while

existing game design patterns and lenses can be used to derive the ideas into functional game mechanics.

Playtest with users phase should take the developed game ideas into use with actual end-user representatives, potentially in an authentic use context. User testing methods that fit the the context should be used – we benefited greatly in the second demo phase from using the co-discovery method suggested for design with children as users. The potential issues identified in the playtesting phase should help further defining the game mechanics in the previous phase.

Finally, **Evaluate results with appropriate metrics** phase should critically evaluate the outcomes of the implemented instances procedural rhetorics, especially regarding their persuasiveness. Used evaluation methods can include expert evaluation, questionnaires or surveys, or data analytics methods. Based on the evaluation, the iterative process can be continued or a satisfiable game version can be deployed.

5.3 Design Guidelines for Children’s Persuasive Game Design

The following guidelines of replayability, universality and real-life correspondence are drawn from our experiences of the BIE cycles of Pikin huone. In the future, they could be followed as principles in designing new persuasive games for children in different contexts, or as a basis for creating heuristics to evaluate existing game solutions.

5.3.1 Replayability

One of the key features that was found essential in developing the game to be persuasive was to make it replayable. In our first demo phase, we tried to design a game to be a linear, story-based experience with the safety content being embedded inside the scenes. However, this clearly undermined its effect, since the players would not pay much attention to the safety-related issues or would even barely notice that they existed.

Our solution of designing the second demo version of the game as a collection of mini-games proved out to be a success. With different mini-games being available, children can choose the ones that found appealing and suit their skills. As small children develop fast, it is more unlikely for one game to suit all ages or stages of development. Hence,

the mini-game approach can be used to provide content with different level of challenge for the different user groups.

Making the content replayable will expose the player into the procedural rhetoric of the game for a longer period of time and supports the player to experience more with the mechanics to see different outcomes and understand the causality from the choices they make. We noticed that enabling the player to play the game in different ways - even against the rules - was one thing that resulted in emergent gameplay and continued interested in the game. Hence, adding more freedom to the gameplay is one possible strategy to make the more more replayable, and subsequently, more persuasive.

5.3.2 Universality

Another key component for success in our game was the universality of themes, environments, characters and audiovisual contents. According to Ermi & Mäyrä (2005), sensory immersion and imaginative immersion are both fundamental parts of gameplay experience. Hence, it is important to invest in high-quality audiovisual form and design the characters and game world in a way that the players can empathize with them and use their imagination. Children's persuasive games should appeal to a wide spectrum of possible players, so the design should be universal in a way that anyone can relate to the game. We used colorful, humanoid characters with caricature-like expressions. Although the children did not necessarily recognize them being aliens, they were able to empathize with the characters and found them funny, which supported engagement with the game. Similarly, the environments were familiar either from everyday environments or elsewhere in the children's culture - the feedback we got from Yle confirmed that using fantastic environments such as space would be good way to provide persuasive content for everyday life in an imaginative way.

Persuasive games compete with a myriad of commercial children's entertainment and need to be distinctive and engaging. In this sense, they share many of the design values Kultima (2009) has presented for the so-called casual games: acceptability, accessibility, simplicity and flexibility. Similarly to casual games, persuasive games for children should reach for universality through acceptable themes and environments, game mechanics that are accessible despite different motoric and cognitive skill levels, and simple gameplay that is instantly understandable and engaging.

5.3.3 Real-life correspondence

Lastly, the correspondence of the game elements with the real-life situations in the players' lives was a key component in mediating the persuasive safety contents to the players. Small children don't have the same abilities to abstract thinking as grown-ups, so it is essential to make the persuasive content connect with their own experiences. We noticed that in the playtesting the children were able to recall situations in their life that the game reflected, which made them more conscious of the game content and hence more open to persuasive content. Using fantastic environments such as the space is still fine as long as the correspondence with the real-world situation is understandable.

Another valuable thing that real-life correspondence provides is a way to include subtle cues into the game that may not be consciously notable to players at first, but can introduce them to concepts that they may identify later in their everyday lives. The evaluators of the game and the participant organizations gave good feedback about including small details like the CE markings and cautions signs in the game. Including real-life information can be thus provided through multiple strategies, subtle and more explicit.

6 CONCLUSION

This thesis has described the design process of a persuasive game to increase children's safety awareness. Action Design Research methodology was used to present the design process through a formal framework and to generate design knowledge. The design of the game was carried out through an iterative design process that produced two versions of the game, the first demo that was used as a proof-of-concept and the second demo that was targeted to publication for end-users in a popular children's game platform. The game was evaluated through playtesting with target group users and by feedback surveys to students with knowledge on games and gaming. The study resulted with a conceptual process model for designing persuasive games and a three guidelines to guide the design of persuasive games for children.

The main contribution of this study is the completed game artifact, *Pikin huone*, which was published in the Yle's *Pikku Kakkonen* children's game platform. The game has attracted an average of 2,000 daily users and has been extended with new content in areas such as fire, elevator, traffic and electricity safety (Tukes, 2015b).

The implications for research of this thesis are to provide knowledge about the design processes of persuasive games that have been previously mostly uncovered in the literature. The presented process model shows how the theoretical concept of procedural rhetoric can be positioned as an integral part of a user-centered game design process. The suggested guidelines could be used as an analytical tool to evaluate existing serious game solutions. The thesis also provides an exemplar of using Action Design Research as a method to conduct game design research. The most notable benefit from using ADR was to emphasize the role of the organizational context as an important contributing part of the design process, a notion which is often lacking in design-oriented studies.

For practitioners, this thesis provides a process model that could be used as a basis for developing persuasive games in different contexts. It emphasizes the importance of adapting a user-centered design approach in similar projects. The three guidelines of replayability, universality and real-life correspondence could be also used to guide new persuasive game projects and evaluate existing solutions. This study also functions as a singular case study into the design process of a persuasive game for children,

demonstrating issues and challenges that might be faced in similar projects and potential practices to overcome them.

This study was limited by the fact that it only examines the one implemented persuasive game project in the context of children's safety awareness. To validate the generalizability of the outcomes of the study, they should be applied in different use contexts with different user groups. There were also limitations in the evaluation methods used in the game development BIE cycles. The evaluation data were collected through a free-form textual feedback survey from a very limited amount of participants. Using more scientific survey instruments such as established questionnaires in addition to the free-form feedback could have provided a more quantifiable results about the quality of the game experience. Also, as the playtesting sessions were individual events that were not followed up with later monitoring, it would be difficult to make conclusions of the long-term effect playing the game has on the children's safety awareness.

Future work on the topic could include using the presented process model and guidelines in developing new persuasive games in other contexts, and based on the experiences further refine and validate the constructs. Also, defining metrics how to evaluate the long-term effectiveness of persuasive games would be a prospective following research topic. For example, using data analytics to evaluate the engagement with the game and hence guide future persuasive game design could provide interesting insights in the future.

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