CHALMERS
UNIVERSITY OF TECHNOLOGY

Designing Games for Internal Training Is Not Child's Play

Guidelines for Designing Games at Ericsson Packet Core

Master's thesis in Interaction Design & Technologies

JENNIFER PANDITHA
ISAK STRÅVIK

Department of Applied IT
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Department of Applied IT
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Cover: The three game concepts developed in this project, refer to section 7.2 for more details.

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Abstract

The aim of this project was to investigate how games can be designed for training purposes at Ericsson Packet Core. A set of 37 guidelines, three game concepts and a prototype were created to investigate how games could be used and implemented. The project was carried out in an iterative manner and feedback was received throughout the project. The guidelines are based on an extensive research study performed in the beginning of the project. To test and evaluate the guidelines, game concepts were created. The guidelines and game concepts were developed in parallel during four iterations. A prototype was developed for one of the games to get hands-on experience and to perform tests with learners from the target group.

The guidelines, the game concepts and the prototype have been developed and tested in close collaboration with Ericsson Packet Core and Ericsson Global Services. Even though they are still in the early stages of development, they could be used for further development of internal training games at Ericsson.

Acknowledgements

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Contents

1
Introduction

As of 2015, the game industry was estimated to 22 billion dollars (ESA 2015), and in 2013 games engaged more than one billion people around the world (Spilgames 2013). This has made researchers consider ways to utilize the power that games have to motivate people to learn. Research in the field of Game-based learning has shown that games promote learning (Van Eck 2006) and have positive effect on the player's development of a number of skills (Kirriemuir & McFarlane 2004, Squire & Jenkins 2003). According to a national study conducted in the United States of 500 teachers who use digital games in the classroom, 70 percent of them said that games increased the students' motivation and engagement levels (Millstone 2012). Sitzmann (2011) found that when games were used for corporate training, the employees had a 9 percent higher retention rate, an 11 percent higher factual knowledge level and a 14 percent higher skill-based knowledge.

Today, Packet Core, one of the business units within Ericsson, applies a traditional approach when supplying training to employees, using instructor lead training and web based self-learning, i.e. reading documents and recordings. Packet Core is looking for new and appealing ways to deliver training to the staff around the world. Games could be used as a complementary medium of communication and internal training. They are also keen to find an approach that motivates new and younger employees to learn. One approach to potentially achieve this could be to use game-based learning. A game-based approach can make education more motivating and fun (Rieber et al. 1998).

Stakeholders for this project are course instructors and employees participating in internal training at Ericsson and the institution of Applied IT at Chalmers University of Technology.

1.1 Research question

How can games be implemented at Ericsson Packet Core for training purposes?

We planned to investigate how different game related research areas can be applied to internal training courses at Ericsson Packet Core to make them more engaging for employees. The research was to be compiled into guidelines, and these were planned to be tested by creating a

prototype. To investigate games that can be used for internal training we have looked into game categories and other relevant research areas. Motivational theories and theories in emotional design were other interesting research area that was relevant to investigate.

1.2 Delimitations

The focus of the project was to look into interaction design and game design aspects when implementing games in training at Ericsson. The focus was on making courses more motivating and engaging for the employees, and not on how much they learn using the games. This was because of our background in interaction design and time limitations of the project. The time frame restricted us from looking into pedagogical aspects of educational games, even if it is an important aspect that needs attention. The result does not include an assessment of the efficiency of using games in training, nor a game that is ready to be used.

1.3 Reading directions

This report is divided into several chapters and a short description of each chapter can be seen below.

In chapter 2 Theory, definitions, theoretical frameworks, relevant concepts and related research are presented to support arguments and discussions later in the report.

3 Background describes Ericsson and its internal training courses that we have looked into, followed by examples of games both inside and outside of Ericsson.

Descriptions of methods, process and tools can be found in chapter 4 Methodology.

5 Planning shows the initial plan we had for this project.

6 Procedure describes the planning and the design process that was used to attain the aim and goals of the project. 6.17 summarizes the design process of the project.

7 Result includes descriptions of the final game concepts (see section 7.2) and the final set of guidelines including motivations can be seen in section 7.1.

In 8 Discussion, discussions about the results, generalisability and the validity of them and other issues can be found.

Finally, 9 Conclusion summarizes the project and states future directions.

If you are an Ericsson employee, you may want to look into 2 Theory to understand different uses of games in game industry and education. Examples of games can be found in 3 Background. To get an overview of the project, refer to the summary of our procedure in section 6.17, results in section 7 Result and 9 Conclusion.

2

Theory

There are many researchers, both academic and professional game designers, who have different definitions of game and categories of games. Many definitions overlap and there are both proponents and also criticism to why games should or should not be used for educational purposes. In this chapter, definitions, theoretical frameworks, relevant concepts and related research are presented to support arguments and discussions later in the report.

2.1 E-learning

Clark & Mayer (2011) define e-learning as "*instruction delivered on a digital device such as a computer or mobile device that is intended to support learning*". E-learning can also be defined as "*the use of computer network technology, primarily over an intranet or through the Internet, to deliver information and instruction to individuals*" (Welsh et al. 2003). Both definitions point to e-learning being a digital form of learning supported by Internet. Research distinguishes between instructor-led synchronous e-learning and asynchronous, self-paced e-learning which includes PowerPoints, listening to recording and reading documents. E-learning can be more effective than instructor-led training but requires planning and effort (Welsh et al. 2003).

There are different forms of e-learning. Simulations and mobile learning are examples of these. Kapp (2013*b*) defines simulations as controlled environments where learners can practice and experience making decisions. Simulations can have more limitations in storytelling whereas games do not have the same boundaries (Kapp 2013*b*). Mobile learning is defined as "exploitation of ubiquitous handheld hardware, wireless networking and mobile telephony to facilitate, support, enhance and extend the reach of teaching and learning" (molenet.org.uk 2007). Sharples et al. (2005) emphasize on the difference that mobile learning is creating learning content to be mobile rather than creating learning for specially designed for mobile phones.

2.2 Games and education

Educational games, i.e. games with learning purposes, are gaining acceptance as a tool for learning, but is faced with the challenge of providing research evidence of the acclaimed ben-

efits (Kirriemuir & McFarlane 2004). The reason for this could be the diversity and complexity of games. There is, however, research showing that games promote learning (Van Eck 2006). Kirriemuir & McFarlane (2004) and Squire & Jenkins (2003) claim that games can have positive effects on player's development of a number of skills: strategic thinking, planning, communication, collaboration, group decision making and negotiation skills. Learning new skills from games can be attributed to the fact that they provide players with the opportunity to learn by doing (Rickard & Oblinger 2003). Virtual learning environments help develop learning and collaboration skills (Gibbs 1999), as well as practical reasoning skills (Wood & Stewart 1987). Games can also be a powerful way of introducing new concepts (Squire & Jenkins 2003). Rogoff (2003) and Gee (2004) claim that the reason for this is that games offer a meaningful and relevant context in which learning is more effective, compared to outside of that context.

Another advantage is that games make the learning experience more motivating and appealing by generating a higher level of positive emotional engagement from the student (Rieber et al. 1998). Games can, compared to a traditional setting, improve participation (Jayakanthan 2002) and motivate passive students to contribute more (Tanner & Jones 2000). They provide a way of motivating students who do not perform well in conventional settings by offering curiosity, fun and social recognition (Dede 2004). Corti (2006) argues that the motivational aspects of games are what attract training and development professionals to investigate the use of game-based learning approaches.

Today's use of games for education has been showing positive results. A study showed that 70 percent of the 500 teachers who use digital games in the classroom, said that games increased the students' motivation and engagement levels (Millstone 2012). Another study performed by Sitzmann (2011) found that when games were used for corporate training, the employees had a 9 percent higher retention rate, an 11 percent higher factual knowledge level and a 14 percent higher skill-based knowledge.

Games do not only have positive effects on a person's skills when it is designed specifically for educational purposes. Studies have shown a positive correlation between having experience in computer games and a person's performance outside the game. Enochsson et al. (2004) found that medical students who were gamers had a better three dimensional perception compared to other students, and therefore performed better in endoscopic simulations. Another study showed that people playing first-person shooter games improved their ability to focus (Bavelier 2012).

2.3 Critique to games and education

As mentioned previously, researchers have had problems finding evidence of the benefits of educational games due to their complexity and diversity. Mitchell & Savill-Smith (2004) also claim that it is difficult to draw any firm conclusion because of conflicting outcomes. Possible negative effects of games include health issues (e.g. headaches, fatigue, mood swings) and psycho-social issues (e.g. depression, less positive behavior towards society in general, increased gambling) (Mitchell & Savill-Smith 2004). A topic which is under a lot of debate is the

negative effects of violent computer games, which includes aggressive behavior and negative personality development (Mitchell & Savill-Smith 2004). There is, however little evidence that support the theories that computer games would lead to negative behavior (Gee 2007).

Stoll (2000) is critical to educational games and describes the transformation as "*turning the classroom into a funhouse*". He argues that students lose focus from reading, writing and scholarship when using computers for learning. Graphical games dull questioning minds and replace understanding, reflection and critical thinking with quick answers and fast action. Students will expect to learn new knowledge without working and scholarship becomes a computer game.

Important to remember is that not all games are good for all learning outcomes, as argued by Van Eck (2006). The outcomes of the experience is also dependent on the player's goals (Squire & Jenkins 2003), meaning that the player must have a desire to learn, even if the game was designed to educate.

2.4 What is a game?

Many authors have their own definition of a game. Figure 2.1 shows different characteristics of a game and if authors agree or disagree with these. A check mark represents an agreement to the characteristic whereas a cross means a disagreement. An empty cell shows that author does not include that particular characteristic in his or her definition.

Researchers	Voluntary	Make decisions to manage resources	System of rules	Has a goal	Uncertain outcome	Quantifiable outcome	One to many players	Outside ordinary life	No material interest or gain	Boundaries of time and space	Subset of reality	Overcoming conflicts or obstacles
Parlett (1999)		✓	✓	✓								
Abt (1987)		✓	✓	✓			X					
Huizinga (2014)	✓		✓					✓	✓	✓	X	
Caillois (1961)	✓		✓		✓				✓	✓		
Crawford (1984)			✓	✓							✓	✓
Suits (2014)	✓	✓	✓	✓					✓			
Costikyan (2005)		✓		✓								
Avedon & Sutton-Smith (1971)	✓		✓		✓			✓				✓
Salem & Zimmerman (2004)			✓			✓		✓	✓		X	✓
Juul (2010)		✓	✓		✓	✓						
Morgenstern & Von Neumann (1953)		✓	✓	✓								
Fullerton et al. (2004)			✓		✓							✓

Figure 2.1: Game characteristics matched with researchers' definitions. A check mark represents an agreement to the characteristic whereas a cross means a disagreement.

Our definition of a game can be found in section 6.1.3. There are different frameworks that can be used to describe and talk about games. Some are MDA, Component framework, The Gamification design framework and Game ontology project.

MDA is a framework founded by Hunicke et al. (2004) that can be used to describe and talk about games. It consists of three parts: mechanics, dynamics and aesthetics. Mechanics are the rules of a game. In a game of tic-tac-toe, one mechanic is that one player marks their symbol, either a circle or a cross, on a 3 x 3 grid system. The interactions between players as a consequence of the mechanics are called dynamics of a game. Placing a symbol in the middle to increase several options of placements or other forms of tactics ruled by mechanics are examples of dynamics. Tic-tac-toe is a game that can be used to pass time, which can be regarded as one of the aesthetics of the game. Hunicke et al. (2004) advocates using the framework as a lens when looking at games. By looking into game mechanics and changing them, one can see how the dynamics and the aesthetics of the game change. One can also look into game aesthetics and try to come up with dynamics and mechanics to achieve a certain aesthetic.

Another framework that can be used to discuss games is Component framework by Björk & Holopainen (2006), which provides a vocabulary to discuss games. It consists of four different

components: holistic components, bounding components, temporal components and structural components. Each component contains a set of terms that describe gameplay.

Werbach (2015) presents a six step process for implementing gamified systems called the Gamification design framework. The six steps are: define business objectives, delineate target behaviors, describe your players, devise activity loop and don't forget the fun, deploy the appropriate tools. Each step contains questions and statements that can be considered when designing.

Game ontology project is a framework for describing, studying and analyzing games presented by Zagal et al. (2007). The top level of the ontology consists of five different elements: interface, rules, goals, entities and entity manipulation. Under each element there is a hierarchy of other elements which can be used to describe games, such as point of view, lives and game goals.

2.5 Categories of games in education

There are several categories of games are games. The definition of each category is not unequivocal and many authors have different views of the categories. Below are descriptions of each category followed by a comparison.

2.5.1 Game-based learning

According to Corti (2006), game-based learning and serious games (section 2.5.2) are analogous. He argues that game-based learning has the potential of improving training through games' engagement and motivation. A term closely related is Digital Game-based learning, which only concerns digital games. Prensky (2003) who is the leading proponent of this term sets forth a view on that today's students are raised with digital technology and have become 'native speakers' in the language of digital media, in contrast to previous generations. He argues that games have transformed learners' preferences and abilities and provides a huge potential for learning. The book Digital Game-based Learning Prensky (2005) discusses how learning has changed, how games teach and why they work. Prensky has been criticized by several other researchers for his strong opinions of games as an educational tool. Nevertheless, Kiili (2005) and Squire et al. (2005) consider Digital Game Based Learning to be the "*newest trend in e-learning*".

2.5.2 Serious games

Serious games are defined as "*games that do not have entertainment, enjoyment, or fun as their primary purpose*" (Michael & Chen 2005). They are "*any form of interactive computer-based game software for one or multiple players to be used on any platform...*" (Deterding et al. 2011). Serious games can be applied to areas such as government and corporate training, education

and health (Zyda 2005). An advantage with serious games according to Squire & Jenkins (2003) and Corti (2006) is the possibility of experiencing situations that are impossible in the real world, because of safety, cost, time, etc.

Zyda (2005) argues that, compared to entertainment games, serious games have more than story, art and software, it has the addition of pedagogy. This addition is what makes games serious. In contrast to the definition above, Zyda (2005) states that the entertainment component comes first and that pedagogy is subordinate. Nevertheless, regardless of which aspect is to be considered superior, Michael & Chen (2005) point out that fun can be the result of learning something new. Furthermore, serious games are not only played by experienced players, but are more likely to be played by first-time players compared to entertainment games. Serious games must therefore be accessible to a wider audience. Michael & Chen (2005) also argue that it is important to consider simplifications that are often made in entertainment games when designing for serious games. For example, serious games should act on a conscious decision by the player rather than chance, and therefore it might be inappropriate to use randomness. Likewise, the communication in entertainment games is often perfect, i.e. no delays or misunderstandings. Serious games on the other hand should sometimes reflect that communication is not always perfect (Michael & Chen 2005).

2.5.3 Gamification

Today, there are several definitions of the term Gamification. Deterding et al. (2011) propose gamification to be "*the use of game design elements in non-game contexts*". As the definition states, gamification is identified as the addition of game elements, such as points, badges, levels and leaderboards, to a non-game context. The context of use could be for training, health or news and Deterding et al. (2011) argues that gamification should not be limited to a single context of use.

Another definition of gamification is made by Kapp (2012) and is formulated as "*using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems*". Zichermann & Linder (2013) and Kumar (2013) agree with this definition and emphasize on the engagement and motivational aspects of gamification. Game thinking is the most important element of gamification and concerns the idea of converting an everyday activity, such as running or jogging, to include elements of competition, cooperation, exploration and storytelling.

In contrast to the definition by Deterding et al. (2011), Kapp (2012) argues that the real power of gamification comes from implementing other elements of games, such as engagement, storytelling, visualization of characters and problem solving. Only adding mechanics like scores, points and rewards does not take advantage of the full potential of gamification and is a huge design mistake (Kapp 2012). By the same token, Zichermann & Linder (2013) argue that one must design for a thoughtful and meaningful experience. According to Kapp (2012), a good approach would be to consider the entire experience of the learner and not just one or two elements. He claims that many elements of gamification is based on educational psychology

and can therefore be used to promote learning.

Kapp (2012) expands on the definition made by Deterding et al. (2011) to include more game elements, not only scores, points and rewards, but also engagement, storytelling and problem solving. Deterding et al. (2011) mention that engagement is an important factor in gamification, but they do not include it in the definition. They chose to create a definition which separates gamification from serious games to allow more detailed research into the concept. Considering this fact, Kapp (2012)'s definition of gamification does not make the same separation and therefore classify serious games as a subset to gamification.

2.5.4 Pervasive games

Pervasive games use the real world as its game board and enrich the reality by adding a game layer (Montola et al. 2009). They expand the magic circle of play that exist within games, either spatially, temporally or socially (Montola et al. 2009, Salem & Zimmerman 2004). The authors use the term "magic circle" when defining games. The magic circle is a term that has been used to describe the game world. Pervasive games take the pleasure of games and apply it to the physical world. Since the players know the rules and the setting of the game, they can go in and out of the magical circle or the game world as they please (Montola et al. 2009). The rules of pervasive games use constraints of the real world. This can be a gratifying experience since the game mechanics of pervasive games encompass the real world constraints (Montola et al. 2009). Constraints could be physical, such gravity and wind, or emotional such as fear and suspension.

2.5.5 Edutainment

Edutainment is a concept that combines entertainment with education (Keizer 1992). Researchers and companies have tried to connect games with learning for decades. One of such examples is edutainment. When multimedia boomed for some decades earlier children's games were created to teach reading, mathematics and science (Michael & Chen 2005). The primary target group was preschool- and young children. Edutainment has been criticized for making a passive learning experience. In fact, studies show that people learn more when they are engaged and participate in the learning (Resnick 2004). According to Van Eck (2006), the term has been described as "boring games and drill-and-kill learning" and that the learner does not need to actively participate in edutainment games.

2.5.6 Comparison of game categories

The difference between "*game*" and "*artifact with game elements*" can often be difficult to see. Deterding et al. (2011) distinguish between serious games and gamification by denoting serious games as "*full-fledge games for non-entertainment purposes*", whereas gamification, or "*gamified*

application", "*merely incorporate elements of games*". Serious games satisfy all necessary condition for being a game, while gamification does not. They argue that the boundary is empirical, subjective and social. Determining whether an artifact is "*a game*" or a "*gamified application*" is dependent on the designers' intentions or the user experience and enactments.

Two terms which authors such as Prensky (2003) and Corti (2006) use interchangeably is serious games and game-based learning. Comparing serious games and edutainment, Michael & Chen (2005) argue that they both have the same goals, but that serious games extend beyond teaching facts and rote memorization, and instead include all aspects of education, i.e. teaching, training and informing. Serious games are also appropriate for use at all ages, in contrast to edutainment of which the primary target group is preschool- and young children.

Compared to other game categories described earlier, Pervasive games widen the game world to include the physical world in the game world. Montola et al. (2009) argue that pervasive games expand the game definitions of Huizinga (2014) and Salem & Zimmerman (2004) who excluded game from being a part of ordinary life in their definitions of games. Since serious games are, according to one definition, computer-based, serious games and pervasive games can be regarded as separate game categories. None of the definitions of gamification conflicts directly with the definition of pervasive games so there could be games that could both gamifications and also be a pervasive game.

2.6 Interaction design

Rogers et al. (2011) define interaction design as the creation of interactive products to support everyday interaction and communication. According to Lowgren (2014), interaction design is "interaction design is about shaping digital things for people's use".

2.7 Instructional design

Merrill et al. (1996) present instructional design to be the development of learning experiences, which promote the acquisition of specific knowledge and skill. Instructional science is based on assumptions of learning and been proven by empirical evidence and which can be used to design learning experiences Merrill et al. (1996).

2.8 Game design

Game design is about designing objectives, rules and procedures to create a compelling player experience (Fullerton et al. 2004). The most important role of a game designer is, according to Fullerton et al. (2004), to be an advocate for the player and see the world through the eyes of the player.

2.8.1 Player types

When designing games for a larger crowd player types can guide in when deciding mechanics. Bartle (1996) introduced four player types for MUDs (Multi-User Dungeon games): killers, achievers, explorers and socializers. Kim (2014) revised Bartle's player types for casual, social and educational games. These player types are explorers, creators, collaborators, competitors. Explorers are individuals motivated by discovering the ins-and-outs of the game world as well as accumulating and showing off knowledge and enjoy challenging the game world. Creators are motivated by opportunities for self-expression and love tools that let them personalize their experience and express their uniqueness. Competitors are motivated by testing their skills, seeing how they perform. They are triggered by comparing their performance. In contrast to competitors, the Collaborators are motivated by working with others towards a greater goal and enjoy team work.

2.8.2 Game genres

Game genres are categorizations of games mostly used by the game industry (Björk & Holopainen 2006). Wolf (2002) mentions 40 different games genres. The term has been considered problematic since not all games can be categorized within one genre (Adams 2009). Björk & Holopainen (2006) mention that even though the term can be problematic, that game genres can be used to identify game components.

2.9 Emotional design

It can be interesting to look into emotional design since game aesthetics are an important part of game design (Shelley 2001). Two models that can be applied when designing for emotion are The Emotional Design Model and A.C.T. model. The Emotional Design Model was defined by Norman (2004). The framework defines three levels of emotions: visceral, behavioral and reflective level. The visceral level consists of the first impressions a product conveys through our five sensory inputs. Examples can be the roughness of a table surface or the beautiful color scheme of a website. Behavioral level is about the functionality and the usability of a design. How the buying process works in an e-commerce application or moving candies in Candy Crush. The third level, reflective level, is about satisfaction of the product and is highly dependent on the individual.

The second model which is called the A.C.T model stands for Attract - Converse - Transact and is a framework founded by Van Gorp & Adams (2012). The authors see all interactions with designs as relationships and the framework is based on how the reptilian, mammalian and the human brains work. The Attract component is about desirability of the design. The Converse component focuses on the usability of the design. The transact component refers to the usefulness of the product and if a product fulfills its function (Van Gorp & Adams 2012).

2.10 Motivational theories

There are several theories regarding motivation that are related to game design. The following theories could be used to motivate learning or to create a more motivating gameplay (Learning-Theories 2015).

One motivational theory is the flow theory which was originated by Mihály Csíkszentmihály (Csikszentmihalyi & Csikzentmihaly 1991, Enders 2013). Many authors refer to Csíkszentmihályi's flow theory and how games make use of flow in gameplay. Flow is described as an optimal mental state in which people feel they are engaged. People tend to be in flow when the skill level matches the task challenges (Learning-Theories 2015). When the challenge level is too high compared to the skill level, people tend to feel anxious. When the opposite happens, when the skill level outweighs the challenge, people find the challenge boring (Csikszentmihalyi & Csikzentmihaly 1991).

Maslow's hierarchy of needs is another motivational theory and is one of the most popular motivational theories but has also been criticized due to several reasons. One critique is that Maslow denies the importance of culture as basic human need (Neher 1991). Maslow's hierarchy of needs is often visualized as a pyramid like the one that be seen in figure 2.2.

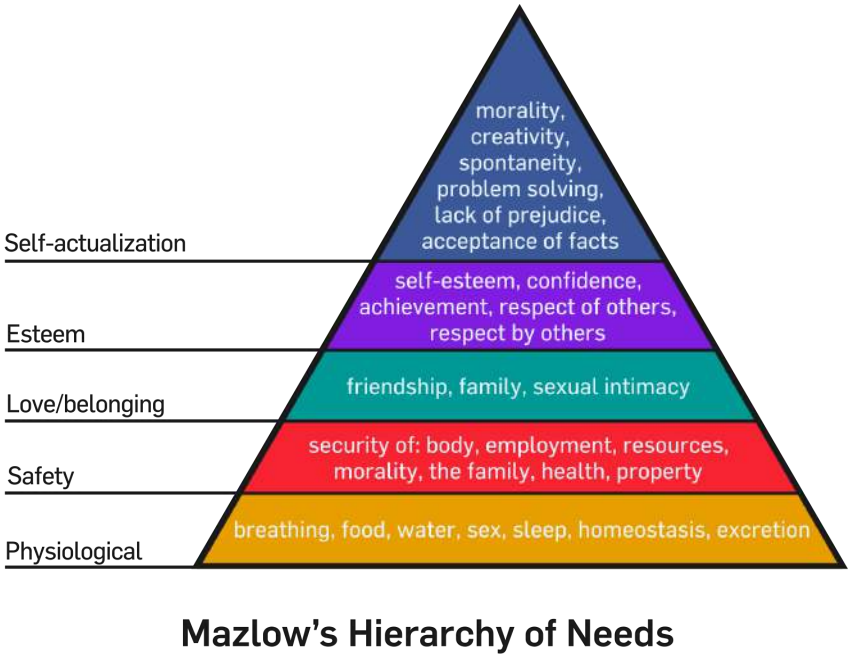

Figure 2.2: Maslow's pyramid of needs retrieved from Wikipedia.org (2009).

Another popular motivational theory which was originated by Ryan & Deci (2000) is called Self-Determination Theory (SDT). The theory distinguishes between intrinsic motivation and extrinsic motivation. Intrinsic motivation is acting upon pure personal interest or enjoyment whereas extrinsic motivation is doing something to gain rewards from external reward systems such as bonuses, badges and points. When a student is intrinsically motivated by his or her studies it means that the subject itself is interesting. An extrinsically motivated student could study just to get a certain grade or to gain status among other students. To use extrinsic motivators more successfully they need to attend basic human needs. Ryan & Deci (2000) divides personal needs into three categories: competence, relatedness and autonomy. Extrinsic motivators can be perceived on a scale from external to internal whereas intrinsic motivation can only be perceived as internal drive (Ryan & Deci 2000, Enders 2013).

There is also a motivation design model specially focused on education that is called ARCS. It was founded by John Keller. ARCS stands for Attention, Relevance, Confidence and Satisfaction. According to this model motivation of a learner is governed by these four factors. The model provides methods and guidance to gain the attention of the learner, establishing relevance and providing for confidence and satisfaction. The methods can be applied classroom education as well as in corporate training (Keller 1987, Learning-Theories 2015).

2.11 Learning theories in games

It is difficult not to look into learning when creating educational games since learning is an essential part of creating educational games. However, as mentioned in the section 1.2, the focus of the project is to look into game design therefore we have limited learning research to include types of knowledge, types of learning, KSA and learning objectives.

Kapp (2012) presents seven different types of knowledge: declarative knowledge, conceptual knowledge, rule-based knowledge, procedural knowledge, soft skills, affective domain and psychomotor knowledge. Four of them have been considered important for this project and they are, declarative, conceptual, procedural and problem-solving. Declarative knowledge includes acronyms, facts and jargon that are important to know in any organization or academic discipline. Games that help acquire this type of knowledge are essential to enable further learning in any organization (Kapp 2012). Conceptual knowledge consists of groupings of similar knowledge. For example, mathematical proofs or an organization's structure are examples conceptual knowledge (Kapp 2012). The third type of knowledge, which is called procedural knowledge, includes step-by-step instructions to perform a task (Kapp 2012). The last type of knowledge, Problem-solving, was not part of the original list of knowledge and is defined as problems or knowledge that has not been encountered by the learner before (Kapp 2014*b*). According to Sitzmann (2011), post-training self-efficacy was estimated to be 14% higher when using declarative knowledge gained by simulation games and the same number for conceptual was 9%.

There are also different types of learning and the original Bloom's taxonomy differentiates the types of learning into six categories: Knowledge, Comprehension, Application, Analy-

sis, Synthesis, and Evaluation (Krathwohl 2002). Several researchers have revised the original taxonomy. Krathwohl (2002) revised the taxonomy Remember (Knowledge), Understand (Comprehension), Create (Synthesis), Apply (Application), Analyze (Analysis), and Evaluate (Evaluation). Kapp (2013*b*) revises the taxonomy to connect it with different types of knowledge.

Kapp (2013*b*) states it can be useful to divide content into three components knowledge, skill and attitude when creating learning games. The knowledge component includes terms and processes the learner should learn. For example, differences between nodes, names of the nodes, what each node does, difference between voice and data networks could be knowledge the learner needs to know. The second component consists of the skills that need to be learned. Skills should be modeled in games to mimic real world behavior. An example of skill learnt through a simulation could be to perform a virtual surgery to learn how to perform surgery. If the game is used to teach or change attitude, the third component is which attitude the learner should have after completing the game. An example of the attitude component can be instilling learners to wanting to learn more.

The Terminal Learning Objectives (TLO) states the overall goal with the course, what content the game should teach and what the learner should attain by playing the game. The Enabling Learning Objectives (ELO) describe the steps in accomplishing the TLO (Kapp 2013*b*).

3
Background

This chapter describes Ericsson's current internal training courses and what knowledge they cover, followed examples of games both inside and outside of Ericsson.

3.1 Ericsson

Ericsson is a large telecommunication company originated in Sweden and has 25,300 R&D employees. According to Ericsson (2015), approximately 40% of all global data network traffic runs through their equipment. One of its product units is called Ericsson Packet Core and works with 2G, 3G and the 4G data networks. As a business unit, Ericsson Packet Core is looking to find new and appealing ways of delivering training.

Today, Ericsson uses two types of internal training: instructor-led learning and web based self-learning, also known as e-learning. They can have two different target groups: Ericsson employees and Ericsson customers. Courses vary from overview courses to in-depth technical courses. The instructor-led courses range from two hour courses to courses that last several days. The instructor plans the material including demonstrations and reading material. In e-learning courses that are available at Ericsson internal websites, there are many courses that include reading documents and recordings, which are asynchronous forms of e-learning.

There are several aspects that can affect the means of delivering training to Ericsson employees. Some of the aspects are: geographical distribution of team members and continuous change of knowledge. Since many team members are distributed in different countries and travelling has been restricted due to sustainability policies, internal training needs to be accessible from different parts of the world and in different time zones. Therefore many courses are available online. Since Ericsson is a large technical company many courses need updating continuously and therefore the courses need to be easily updated.

Most of the internal training courses are available in Ericsson's intranet. Examples of courses are telecommunication network overview, VoLTE and Internet of Things (IoT). The network overview can be described in many ways. One of the most used overviews is a logical concept map of the network that is described to new employees. Telecommunication networks, hereafter called network, consist of nodes that have different functionalities in the network. There

are three kinds of networks with different capacity, namely 2G, 3G and 4G (also known as LTE). Both 2G and 3G networks have a circuit-switched network for voice transfer and a data packet networks for data transfer, whereas 4G networks are only for data packet transfer. The nodes for each network differ from one network to another. For instance, a 4G data network contains the following nodes: eNodeb, MME, EPG and SAPC whereas the 3G network contains masts (not a node), BSC, SGSN and GGSN. There are more nodes involved than those mentioned but they are sufficient to explain the network at an overview level. Packet Core works with the data packet networks for 2G, 3G and 4G and work with the core nodes (i.e. SGSN/MME and GGSN/EPG). To illustrate the 4G network and its nodes, a demo wall has been built at Ericsson Lindholmen. The wall is 10 meters wide and 4 meters tall and contains working nodes and antennas that are connected to each other.

Each node has several functions and signals and parameters are transferred between nodes. To explain and contextualize these, use cases are used. A use case is a scenario with defined prerequisites and configurations that help employees understand the context for the interaction of signals and parameters. To visualize the use cases, many R&D units are using sequence diagrams.

VoLTE and Internet of Things courses are specific uses of the networks described earlier. VoLTE stands for voice over LTE and is a Ericsson feature that enables calling through the data packet network (Ericsson.com 2014). This course goes into more technical detail compared to the network overview and is more specific to the LTE network. Internet of Things (IoT) is a vision of connecting 50 billion devices by 2050. Ericsson is part of the initiative of reaching this goal together with other corporate partners (Ericsson.com 2015).

3.2 Games inside of Ericsson

There have been attempts to create more synchronous forms of e-learning. Ericsson Global Services have made attempts at gamification and creating serious games. Examples are Technology for Good, Order to Cash and Export Ernie 2, which however are not publicly accessible. The first game is a game concept that has not yet been implemented and is a game where the player places antennas in a city to keep the population happy. This game is made for branding purposes and aimed towards people outside of Ericsson to learn what the company is developing. Order to Cash is a gamified e-learning course where the goal is to learn how to create contracts with customers. The learners need to answer multiple choice questions correctly to reduce a financial metric from a value of 160 to 100. The gameplay is linear and incorrect answers lead to views with information test and video clips. The third example, Export Ernie 2, is a 2D platform game and is a serious game which teaches what legal issues one could encounter when exporting and releasing products. Players can explore the platform and enter rooms where questions need to be answered.

These examples of games have been created outside of Packet Core. A problem with internal training courses is that that the material is not always relevant since information continuously changes. Employees usually ask other employees when they need to know something. Since

some employees work on developing new technologies, courses covering those areas have not always been developed, which was mentioned by an Ericsson employee.

3.3 Games outside of Ericsson

In 2014, 40% of the world's internet users played games online. The growth of online games can be partly explained by the growing trend of mobile devices (yStats.com 2014). Mobile games that have been interesting to look into for this project are Lumosity and Flight control. Lumosity is a set of games based on research in neuroscience. One example of a game in Lumosity is Lost in Migration which is based on the Flanker Task by psychologist Charles Eriksen. Lumosity was ranked number one in the education category in App Store in 2014 and was also the Editor's choice in Google Play the same year (lumosity.com 2014). Flight control was introduced to App store 2009 and the player assumes the role of a flight controller. The goal of the game is to land as many plane and helicopters on the correct runway as possible (MacWorld 2009).

There are several applications that use gamification to create engagement in non-game activities. A mobile app called Duolingo (2015) gamifies the activity of learning new languages. The gamified knowledge sharing platform Stack Overflow is a website where people can ask programming related questions and vote for answers. Answering and asking questions contribute to one's reputation on the forum. Stack Overflow is a part of Stack Exchange which has expanded to including discussions other than programming (Exchange 2015). Other examples are gamified applications that promote running, Nike+ (2015) and Zombies, Run! (Zombies 2015, Fuchs et al. 2014). There are also several gamification platforms, such as Badgeville, Bunchball, BigDoor, Axonify, GamEffective and Foursquare (Fuchs et al. 2014, Kapp 2013*b*). These platforms let course instructors gamify their own content by adding points and badges. This manner of gamification is however, unadvised as mentioned in section 2.3.

Serious games can be used for branding, recruitment and educational purposes. There are several examples of serious games and an extensive list has been compiled by Susi et al. (2007). Two examples of branding games are Intel's IT Manager Game (Gershon 2009) and Volvo's Transporters game (HelloThere 2013). Intel's game is an advergame, a game created to promote a brand name, and it simulates an IT department. Transporters is a racing game that promotes Volvo and its trucks. A more academic example of serious games is FoldIt, which was a serious online puzzle game and was connected to protein structure research. Within 10 days after the release of the game, the players found protein folding patterns that researchers have tried to tackle for 10 years (Foundation 2015). Americas Army (2015) is a branding game which promotes the US army and is used for recruitment purposes. Another example of a serious game is Equalize, a platform game, that teaches about diabetes and its implications. There are several versions of this game targeting different age groups (HelloThere 2013).

Examples of pervasive games are The Amazing Race, Geocaching and regular treasure hunts (Ihamäki & Luimula 2013, Montola et al. 2009). The Amazing Race is a competition between 11 pairs and is hosted by the American TV channel CBS. The teams are travelling and upon arriv-

ing on a destination they get a physical or mental challenge that they need to complete. When the challenge has been completed, the team will learn the next location. The goal is to reach the last destination first (cbs.com 2015). Another example of a pervasive game is Geocaching, which is a treasure hunting game using GPS-enabled devices. The goal is to find a geocache which is container that is hidden at a certain GPS location (Geocaching.com 2015).

4

Methodology

There are several different approaches to solving problems, two of them are engineering approach and design approach (Rittel & Webber 1973*a*). The engineering way includes a linear systematic approach of a project divided into distinct phases, and the problem statement and solution criteria are definable. This type of problems is called *Tame problems* (Zagal et al. 2007, Rittel & Webber 1973*b*). When approaching a problem as a designer, however, there is no clear separation of the activities in a design project. Defining, synthesizing and evaluating the problem occur at the same time (Rittel 1987). The problem itself and the understanding of it are constantly changing during development. This is often the case, according to Buchanan (1992), Stolterman (2008), Rittel (1987), for any design practice, including game design (Zagal et al. 2007). Rittel & Webber (1973*a*) has described these problems as *wicked problems*, and presents ten aspects which characterize them. Approaching these kinds of problems in an iterative manner makes it easier to adjust and adapt to the changing constraints of the problem.

Regardless of which approach is used, triangulation can be applied and refers to the investigation of a phenomenon from (at least) two different perspectives, i.e. using different data gathering techniques (Jupp 2006). Compared to using a single theory or user testing method, triangulation can decrease bias (Jonsen & Jehn 2009) and validate the result by pointing to similar results yielded from the use of different methods (Jupp 2006).

4.1 Design Processes

There are different processes to apply when using a design approach. In this section there are three interaction design processes, one instructional design process and a game design process.

4.1.1 Jones' design model

The model presented by Jones (1992) consists of three stages: Divergence, Transformation and Convergence. In the Divergence phase, ideas are gathered to be able to see different alternatives. In the second phase, which is called the Transformation phase, the ideas collected in the

first phase are reviewed and refined. By refining ideas, designers can be able to understand the ideas and ease the next stage, which is called Convergence. It is the last stage of this process, in which ideas are chosen for further development.

4.1.2 Interaction design lifecycle model

A design process originated by Rogers et al. (2011). The model consists of four stages: establishing requirements, designing alternatives, prototyping and evaluating. This process is an iterative purpose. When the process has been iterated a number of times a final product is created (Rogers et al. 2011).

4.1.3 Design thinking

Design thinking is a process used to drive innovation (Brown et al. 2008). IDEO, a global design company, sees this process as a system of spaces rather than a design process (IDEO 2015). According to them, there are three spaces of design: inspiration, ideation and implementation. These spaces can overlap each other. With inspiration they mean researching why the design is needed and the context for it. Ideation space includes generating, refining ideas. In the third space is when the refined ideas are implemented.

4.1.4 ADDIE

A design process used by instructional designers is called ADDIE and starts with the analyze step, followed by design, development and implementation. Each step includes evaluation which is carried out iteratively to revise the design between each step (Learning-Theories 2015). According to Molenda (2003), the origin of this model is unclear and mentions that the model is more suitable as an umbrella term and starting point for looking into specific design procedures.

4.1.5 Game development process

Game development process is an iterative game development process which is divided into three steps: pre-production, production and post-production University (2007). Pre-production contains concept development and design, production is made up by implementation and post-production includes testing and deployment.

4.2 Methods for gathering requirements and expectations

The following sections describe interviews, focus groups and questionnaires which are some methods for gathering requirements and expectations.

4.2.1 Interviews

There are different categories of interviews that can be applied when conducting interviews: unstructured, structured and semi-structured (Fontana & Frey 1994, Rogers et al. 2011). They are generally performed with two people, one interviewer and one interviewee. The first category is unstructured interviews, which have open questions with no defined format or content of the answers. This type of interviews is exploratory and can go into detail of a particular topic. Using unstructured interview can generate rich data and give the interviewer a deep understanding of the topic. Structured interviews, which are the second category, include predetermined questions that are used to standardize the study. The questions are closed and thus require an answer from a fixed set of alternatives. Structured interviews are not as exploratory as unstructured. The range of possible answers has to be known and specific questions must be able to identify. The third category is called semi-structured interviews. It merges the previously mentioned methods and use both closed and open questions. The interviewer has a basic script to follow in every interview, but can exhaust the interviewee of information on a certain topic when appropriate (Fontana & Frey 1994, Rogers et al. 2011).

4.2.2 Focus groups

Focus groups involve a group of people, often three to ten, and is led by a facilitator (Rogers et al. 2011). The facilitator should encourage discussion and involvement by the participants. Selecting participants for the session is governed by having a representative sample of the target population. This method is a good way of identifying any conflicts in terminology or expectations that may exist within the target group (Engelbrektsson et al. 2000).

4.2.3 Questionnaires

A data gathering method that consists of a series of questions designed to thoughts, beliefs, opinions and reasons from participants (Rogers et al. 2011, Blessing & Chakrabarti 2009). It is a good approach when the aim is to reach a large group of people, especially on geographically different areas. Disadvantages using questionnaires are that the answers may biased due political correctness and that poorly formulated questions directly affect the results (Blessing & Chakrabarti 2009).

4.3 Methods for idea generation

Below follows a description of two methods used during idea generation, brainstorming and KJ analysis.

4.3.1 Brainstorming

Brainstorming is one of the most widely used idea generation methods (Curedale 2013). A brainstorming session should cover one single topic and can be conducted both in a group and individually. Kelley (2007) describes seven steps for better brainstorming. A recent meta-analytic review over 800 teams suggests that ideas from brainstorming in groups are not necessarily better compared to the ideas that the same individuals would come up with individually. The study shows three reasons for the inefficiency and they are (Chamorro-Premuzic 2015):

- there is a tendency of individuals free riding
- social anxiety
- talented group members adjusting their work to match the work of less talented members

4.3.2 KJ analysis

KJ analysis is an idea converging method and is also known as Affinity diagram. This method can be applied to structure ideas gathered during the ideation (Beyer & Holtzblatt 1997). Following the three steps presented by Pyzdek & Keller (2014), the notes can be organized hierarchically to show a common structure (Beyer & Holtzblatt 1997). Notes are put in groups of similar issues to gather all ideas relevant to one subject together. The groups are not predefined but emerge from the data.

4.4 Methods and tools for designing concepts

There are different methods and tool that can be used to for designing and some methods are described here. Using these methods and tools can help developers to understand the target group, choosing between alternatives and also find problems in the design in the early stages of design (Rogers et al. 2011, Norman 2004).

4.4.1 Sketching

Sketching is a way of communicating ideas with other people (Buxton 2010). It can be used as an aid of thought and as technical exploration. A sketch should be made fast with the intention of inviting suggestions, criticisms and changes. Due to its lack of completeness, it has an ambiguity which leaves a lot to the imagination. Buxton (2010) presents several characteristics of a sketch, some of them are quick, timely (provided when needed), inexpensive and disposable. In contrast, a detailed image, such as 2D rendering, says "*expensive*" and "*refined*". It suggests that the idea is close to completion and inhibits new input.

4.4.2 Mediating tool

Mediating tools or artefacts can stimulate reflection for the observer. These could be representation(s) of an existing or a future product including simple sketches or fully functional prototypes. When interviewing inexperienced users mediating tools can stimulate discussion and enable interviewees to provide hands-on comments on the sketch or the prototype that is used. Experienced users can give additional feedback that is not represented in the tool (Engelbrektsson et al. 2000).

4.4.3 Participatory design

Participatory design is an approach in which the user is involved in the design and development process (Schuler & Namioka 1993). The developers can gain a better understanding of the users' goals and ensure that the development continues to take the users' wishes into account. Users who have been involved in the development process feel a sense of ownership and are more likely to support the product (Rogers et al. 2011).

4.4.4 Guidelines

Blessing & Chakrabarti (2009) define design guidelines as "rules, principles and heuristics that are useful to follow in attaining some design objectives." Guidelines are designed using research, experience and common sense to help designers motivate and improve their designs. Usually guidelines are written in a prescriptive manner and are seen as Do's and Don'ts of design (Rogers et al. 2011).

4.5 Methods for prototyping

After conceptualization, the concepts need to be prototyped in order to visualize the ideas and be able to get feedback from the potential user of the product (Rogers et al. 2011). One method that can be used for prototyping is paper prototyping. This method can consist of sketched user interface elements that the user can interact with. A facilitator may act as a computer (or another device) and switch between pieces of paper with graphical interfaces to mimic the feedback the user get when the user has interacted (Rogers et al. 2011). An example would be click on a submit button and the facilitator removing the old view to replace it with a confirmation view.

One can also use digital implementation tools to prototype. Kapp (2013*b*) categorizes development tools into three categories: template-based authoring tools, game engines and programming languages & other development tool. Examples of template-based tools are Articulate Storyline and Adobe Captivate which can create HTML5 output. HTML5 + JavaScript + CSS3 and Flash are the main delivery options for e-learning today. HTML5 is growing in popularity due to its multiplatform accessibility (Sharma 2015).

4.6 Methods for evaluation

Evaluating is the process of determining the acceptability and usability of the design (Rogers et al. 2011). Nielsen (1994) describes two different approaches of evaluating, formative and summative. These approaches are performed with different goals. Formative evaluation has the goal of learning about the design while in development to find improvements for the next iteration. Summative evaluation in usability evaluations entails quantitative measuring of usability between a complete product and a competitive produce or measurable usability objectives (Redish et al. 2002). This type of evaluation is carried out when the design is at its final stages to test if the usability has improved sufficiently since the previous version. Rogers et al. (2011) differentiate evaluation between usability testing in controlled setting, usability testing in natural settings, and evaluation without users. Methods described below can be used to conduct both formative and summative evaluation and methods used for gathering requirements can also be used for evaluation.

4.6.1 Usability testing

The primary goal of usability testing is to evaluate the user interface of a product (Dumas & Redish 1999). Tests conducted using this approach involve users from the target group who are observed when performing tasks using the product (Rogers et al. 2011). According to Nielsen (2000), five testers are enough for user testing and this have been mathematically proven by Virzi (1992).

Think aloud is a method for usability testing and is one of the cheapest methods and time-efficient method for user testing (Nielsen 2012). The user tester should be representative of the target group and be given tasks during a thinking aloud test. The facilitator should ask the tester to think aloud, in other words, verbalize the thought as the user performs the given tasks using the user interface (Nielsen 2012).

The method allows the facilitator to discover what users really think about the design. Misconception of the design can appear when the users tell the facilitator what they think while interacting. One of the disadvantages is that thinking aloud is unnatural behavior. Another is that testers do not want to offend the test facilitator or look stupid and may refrain from saying what they actually feel. To keep testers talking throughout the test without making them uncomfortable, facilitator(s) need to ask questions without introducing bias (Nielsen 2012).

4.6.2 Cognitive walkthrough

A cognitive walkthrough involves simulating a user's problem solving process for each step in the interaction, and checking if the simulated user's goal and memory content will result in a correctly performed action (Nielsen 1994). This method is an example of evaluation without users (Rogers et al. 2011).

5
Planning

The work was planned to begin by researching Ericsson's training courses and relevant topics presented in the introduction. Based on this research, appropriate game concepts and guidelines would be developed. One of the concepts was to be chosen to be designed further and implemented into a prototype. The prototype would be used as a proof of concept and to demonstrate how the guidelines could be applied to a course. User tests were planned to be conducted on several occasions to ensure that the prototype meets the users' needs. Documentation of the prototype, guidelines and source code were to be delivered to Packet Core. Work was planned to be put into the final report throughout the project, but the last weeks would be spent entirely on finalizing the written report.

We planned to perform a more specific planning later in the project, including choices of methods and processes. However, the development was planned to be carried out in three iterations. Each iteration included time for implementation followed by a user test of which the feedback would be transferred into the next iteration.

A Gantt chart was created to illustrate the planning of the project, see figure 5.1.

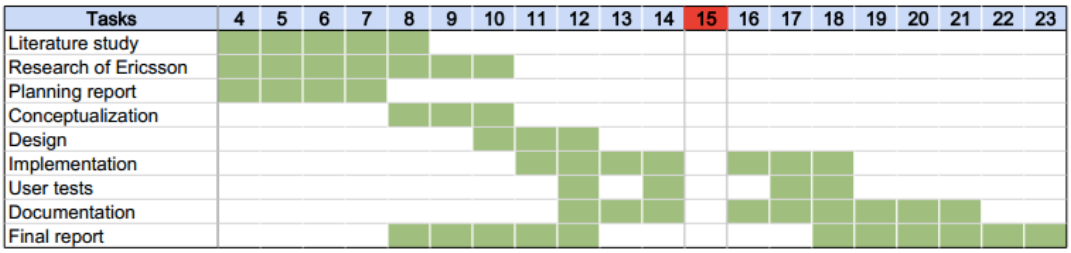

Figure 5.1: The first version of the Gantt chart. The columns in the chart represent number of the week.

6
Procedure

This chapter describes the planning and the design process that was used to attain the aim and goals of the project. The work was performed in an iterative manner with several versions of the guidelines and game ideas. Feedback sessions were carried out throughout the project and how they affected the development is described below.

Initially, the research question was "How can game-based learning be implemented at Ericsson Packet Core for training purposes?". It was later in the development process changed to "How can games be implemented at Ericsson Packet Core for training purposes?". This chapter does also describe why and when the research question was changed, more specifically in section 6.9.

6.1 Pre-study

The purpose of the pre-study was to gain knowledge about the company, the context in which the thesis project was to be conducted and relevant research areas. Based on the pre-study, the frame and goals of the project were defined. Gaining knowledge about the company and the project's context was achieved through unstructured interviews with employees, reading documents and taking part in various presentations.

6.1.1 Research of Ericsson

The unstructured interviews were conducted with employees with different job positions and different experience and knowledge about the telecommunication network and current training courses. In total, fifteen people were interviewed several times at different stages of the project. The first interviews were mainly focused on Ericsson's current training courses and how they were carried out, see chapter 3 for the findings.

Employees from Packet Core explained the telecommunication network for us including the functions of each node. Figure 6.1 was drawn as an explanation and used extensively throughout the project to refer to nodes in the network.

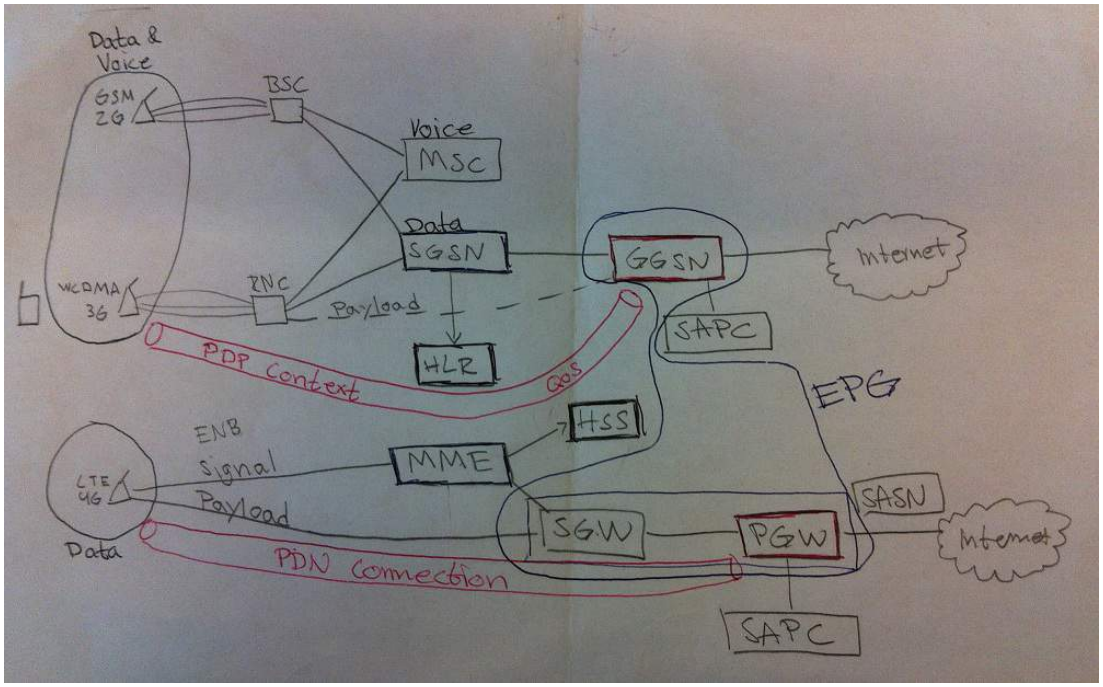

Figure 6.1: A conceptual image of the network and how the nodes are connected.

Interviews were also conducted with Ericsson Global Services which works with providing educational content for other departments. They create various e-learning courses, information videos and some educational games. Packet Core and Global Services have not previously been collaborating in developing games for internal training. We did however realize early on that the employees at Global Services hold a lot of valuable knowledge that we could use in our project. We felt that it was unnecessary for us to start from scratch when we could build on their previous experience. Thus, we asked how they educated new employees and if they had any information documents describing their working progress, or even a list of guidelines that they used. Unfortunately, they did not have these kinds of documents. Nevertheless, we saw a potential in applying their knowledge in both the conceptualization and the creation of guidelines. To this end, we decided to make use of their knowledge through feedback on the concepts and guidelines.

From interviewing the employees we could define the project and the expectations on us. This project is seen as the first step towards understanding how games can be used in training at Packet Core. Its purpose is to lay the groundwork for future projects in this field. The expectations were to perform a study about how games are used in education today. As part of that study, we were going to develop guidelines and game ideas that could be applied to training Packet Core. Since the focus is on the study, we would not implement a complete game. However, our supervisor expressed a wish of having an interactive prototype to make it easier to explain the idea to others, this was not required though.

We discussed the potential that games have to inspire the learner to wanting to know more. By playing the game, the learner can get an basic understanding of different concepts and then after playing continue reading about those concepts through other communication mediums. The game can inform the learner of where to look for more information by referencing to documentation.

By researching Ericsson we saw that the games should be digital, and not physical. As mentioned in chapter 3, travelling has been restricted due to sustainability policies. Hence, creating digital games makes them accessible anywhere.

6.1.2 Research of literature

To gain knowledge about games and how they can be implemented for learning purposes, a literature study was conducted during the initial weeks of the project. The study also included studying research in motivational theories and emotional design. We started of our search with names of authors that we received from our supervisor. By reading their articles and books we found keywords and additional research through references. Some examples of keywords are game-based learning, e-learning, gamification, serious games, educational games, and motivational theories. Although we did not see exactly how we would apply the motivational theories during the project, we saw them as important to study since they are related to games and to create engagement. We used resources such as Chalmers Library, Summon and Google Scholar to search for literature. To ensure the credibility of an author we looked at the citation count, how much of our previously found literature cited the author and whether other authors wrote agreed with the author. We also took an online course in Gamification from University of Pennsylvania which provided us with additional research.

6.1.3 Game definition

The following definition will be used to describe a game and is composed of the characteristics presented in figure 6.2.

A game is an activity in which players make decisions to manage resources and overcoming problems within a system of rules, in order to reach a goal.

Researchers	Voluntary	Make decisions to manage resources	System of rules	Has a goal	Uncertain outcome	Quantifiable outcome	One to many players	Outside ordinary life	No material interest or gain	Boundaries of time and space	Subset of reality	Overcoming conflicts or obstacles
Parlett (1999)		✓	✓	✓								
Abt (1987)		✓	✓	✓			X					
Huizinga (2014)	✓		✓					✓	✓	✓	X	
Caillois (1961)	✓		✓		✓				✓	✓		
Crawford (1984)			✓	✓							✓	✓
Suits (2014)	✓	✓	✓	✓					✓			
Costikyan (2005)		✓		✓								
Avedon & Sutton-Smith (1971)	✓		✓		✓			✓				✓
Salem & Zimmerman (2004)			✓			✓		✓	✓		X	✓
Juul (2010)		✓	✓		✓	✓						
Morgenstern & Von Neumann (1953)		✓	✓	✓								
Fullerton et al. (2004)			✓		✓							✓

Figure 6.2: Game characteristics matched with researchers' definitions. The marked columns represent the characteristics of games that we chose in our definition of a game. A check mark represents an agreement to the characteristic whereas a cross means a disagreement.

Figure 6.2 summarizes different definitions of games from researchers. As seen in the marked columns of the table, three of the four characteristics have majority of proponents. We chose to include overcoming problems because we think that most games include a challenge or set of challenges that a player needs to solve to reach the final goal. On the other hand, we chose not to include other game characteristics with four proponents for different reasons. One such characteristic is that there is no material gain in games. We ruled this one out because games of poker include material gain in form of money even when people are not playing poker professionally. Another characteristic that we did not include in our definition was voluntariness. One can force someone to play a game and that game does not stop being a game just because a game is involuntary. The third characteristic, "uncertain outcomes", can be a part of many games but we see this characteristic as a component of a good game rather than a characteristic of a game in general.

6.1.4 First replanning

After some time was spent on researching theory and methodology, we revised the previous planning and made more decisions on what methods to apply. We planned to use a design approach and to follow the Design thinking process since the research question is a wicked problem. We therefore planned to work in an iterative manner throughout the project with three iterations, where each one lasts for two weeks.

The study, which is the main focus of the project, contains four steps, research, guidelines, game ideas and feedback. The research of Ericsson and literature was performed during the pre-study. Guidelines and game ideas are developed based on the research and feedback received iteratively throughout the project. In addition to the study we planned to create a prototype for one of the games and test it with users.

To answer our research question and create a base for future projects, we wanted to create a set of guidelines. These were going to be based on research about games and education, for example, serious games, gamification, pervasive games, e-learning and motivational theories. To triangulate the data, several theories were to be researched including criticism towards them. Semi-structured interviews were planned to gather feedback and learnings from employees at Global Services from their previous projects. They would also review the guidelines since they have previous experience in this field.

To test the guidelines, we wanted to create three concepts based on the guidelines. We planned to have several brainstorming sessions to elicit ideas for concepts and structure them using KJ analysis. In addition, two concepts, already developed by Ericsson, were to be analyzed using the guidelines.

We planned from the beginning to develop a prototype even though this was not required by our supervisor. Thus, we were going to choose one of the game ideas to implement as a prototype. The prototype was to be user tested three times by employees at Packet Core using formative testing methods. Weekly meetings, using semi-structured interviews, were also planned to be held with Ericsson employees to involve them in the development process, i.e. participatory design.

As the research question is a wicked problem, i.e. the understanding of it constantly changed throughout the project, we did not decide every detail about the project from start to be able to adapt to the changing circumstances. In fact, we consciously planned to make some of the decisions later in the project. We wanted to keep the project as broad as possible to create an appropriate base for future projects. For instance, after the pre-study we had familiarized ourselves with different categories of games, such as gamification and serious games. There were no obvious advantages of choosing one of the categories from the beginning. We did not know which one would work well at Ericsson, so we decided not to choose an approach from the start but rather to keep the project broad and develop the concepts and guidelines based on the research and see where they ended up. Thus, we did not restrict our development by having guidelines that only considered one of these categories.

A Gantt chart was created to visualize the planning discussed above and which can be seen in figure 6.3 .

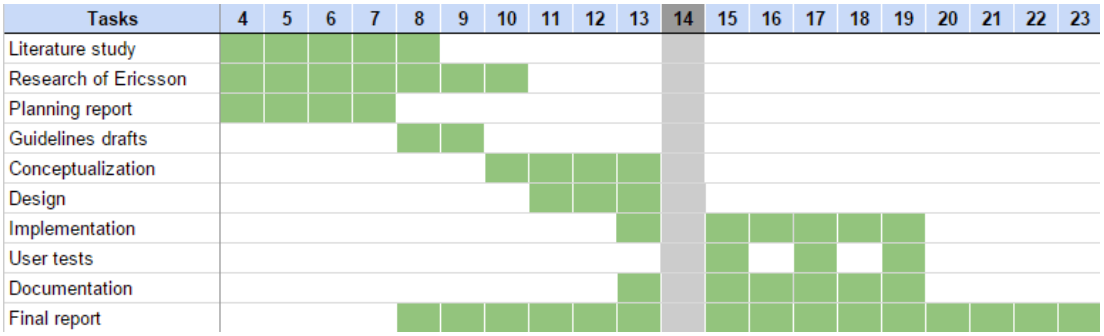

Figure 6.3: The second version of the Gantt chart.

6.1.5 Target groups

There are several potential target groups that we identified during the interviews in the pre-study. We categorized them into Ericsson external and Ericsson internal. Figure 6.4 shows the target groups that belong to each category.

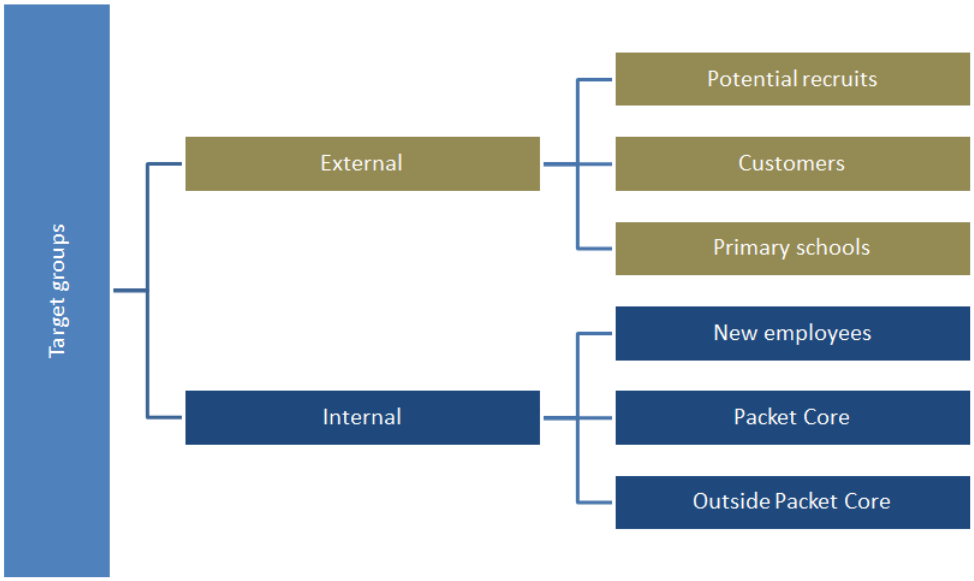

Figure 6.4: The potential target groups that were identified during the pre-study.

We needed to establish the user needs and goals to be able to plan and define the project

delimitations. They were elicited through interviews with Ericsson employees during the pre-study and compiled into a list of short and clear bullet points. The list was confirmed by our supervisor at Ericsson. The needs and goals were defined as the following.

Needs

- Being able to access the game anytime and anywhere

Goals

- Being engaged and having fun
- Learn
- Don't take up too much time

6.1.6 The purpose of the project

During the initial weeks of the project we had problems defining the goal and purpose of the thesis. After having interviews with Packet Core employees we saw several different paths that were possible and did not know which one to take. During interviews with Global Services we were presented to an existing game concept, namely Technology for Good. We were also introduced to the game Order to Cash by the employees at Packet Core. We felt at this point that we could take inspiration from these games when designing our game concepts. The fact that Technology for Good was focused on branding triggered an idea for us to make such a game. However, our project was about game-based learning, and not branding, which would have meant that we needed to change course completely. To make the possible paths for us to take more concrete, we created a flowchart, shown in figure 6.5, that illustrates the different alternatives we had.

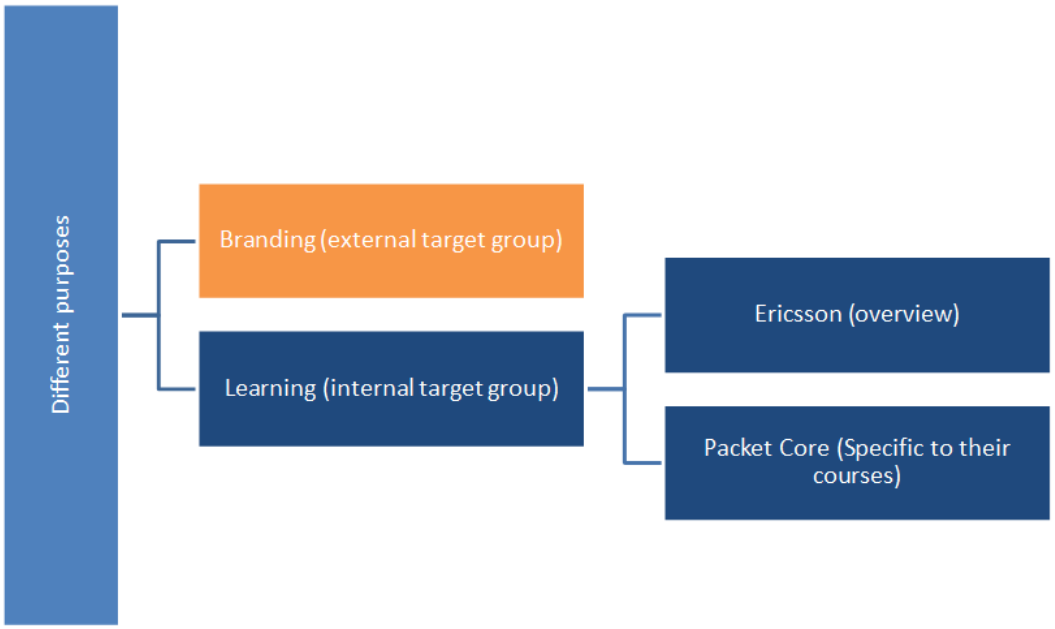

Figure 6.5: The paths that were possible to take in this project.

We presented this image to our supervisor to discuss the various paths. One path was developing a game which would be focused on informing non-Ericsson employees what the company is working with. The other path was going towards a learning game for Ericsson employees. On this path, we had two alternatives to the focus. We could either develop a game to teach about Ericsson in general or focus on content related to Packet Core. The supervisors did not consider it to be a good idea to change path, and argued to maintain the initial focus which was to study how game-based learning could be used at Packet Core. We agreed and decided the purpose of the project to be game-based learning at Packet Core.

6.1.7 Focus on engaging rather than learning

We decided from the start of the project that the games will not be focused on teaching, i.e. how much the employees will learn by playing a game. The focus will be on developing a game concept which is motivating and engaging for the employee. The reason for this decision is mainly because of the thesis proposal emphasized on finding an approaching that motivates employees. This decision gained support from employees of Packet Core. Moreover, we reasoned that teaching and pedagogy are very large subjects and different from interaction design which we have previous experience in. We felt that we would not have time during this project to research pedagogy enough to make any reasonable claims. However, we saw the possibility

of creating a game which is motivating and in that way improve the learning, even though we will not be able to test this.

6.1.8 Choice of courses to focus on

In the beginning of the project we discussed whether we would find an existing game and adapt it to a course or design our own game. During the pre-study, we investigated different games and game engines that exist today to find out if they could be incorporated into a course. Choosing an existing game would mean that a lot of constraints would be put on the design. We felt that we would be too restricted if we were to choose to adapt an existing game. Thus, we chose to take inspiration from everything we learned during the pre-study and design our own games.

We were then faced with a decision of how to approach the design. The following two alternatives were discussed with the supervisors at Ericsson.

- Design a game based on the pre-study and then choose the course in which it should be applied.
- Choose a course first and then design a game for that particular course, based on the pre-study.

The latter approach was chosen because we wanted to know what we were designing for. We felt it would be difficult to design a game without knowing where it would be applied.

To get a broader view of how games could be incorporated into the internal training, we decided to design three games for three different courses. We wanted the courses to be different in regard to the application area and the level of knowledge provided, thereby studying how the design differs between games for different kinds of information. We asked our supervisor at Ericsson to pick three courses. The courses they chose were:

- An overview course describing the telecommunication network on a high level.
- An overview course about the basic functionality in Internet of Things (IoT).
- A detailed course of how Voice over LTE (VoLTE) works.

6.2 First iteration of guidelines

After the pre-study we began to develop the first version of the guidelines document, as according to our plan. The pre-study consisted of examining research in the subject matter. When it was time to start developing guidelines however, we shifted towards a study of game design processes and game design practices. It included reading through literature about best practices and how to apply the knowledge we obtained during the pre-study. We analyzed the information gathered and elicited a first version of the guidelines document, based on what we considered important to include when designing game-based learning at Ericsson. The first

version did not contain complete guidelines, but was a compilation of areas which we thought it would be interesting to create guidelines for. The areas were grouped according to their area of concern into 'Game Design', 'Designing Content for Learning', 'Motivation' and 'Game Aesthetics'. We did not put much thought behind formulating the titles, instead, they only identified the areas which we planned to develop later. Each area was however found through the research and was supported by literature.

Below are titles identifying each area, see Appendix A for the complete document.

Game Design

- Progression
  - How to measure
  - Leaderboards
  - Game Levels
  - Reward effort
- Gameplay Rules
  - Rules
  - End conditions
  - Goals and Challenges
  - Time-based activities
  - Randomness
  - Collaboration
- Gameplay
  - Freedom to fail

Designing Content for Learning

- Learning objectives
- Part of a larger structure
- Learner in control
- Interactive experience
- Matching Game Strategy with Content Type

Motivation

- Intrinsic motivation

Game Aesthetics

- Stories and Characters
  - Story
  - Characters
- Fun

As mentioned previously, we realized early during that the employees from Global Services possessed a lot of knowledge that we could make use of in the development of the guidelines. At this point in the project, we considered having two ways of making use of the knowledge. We could start by thoroughly interviewing the employees and in that way retrieve their knowledge and create guidelines. Alternatively, we incorporated recurring feedback session in the iterative approach (described above) to get their perspective on the current guidelines draft throughout the project. We chose the second approach which we thought would work well with our iterative work. As such, the drafts could be revised several times and through their feedback, we could see if there were any guidelines missing and which were most important and change the list accordingly.

6.3 Second replanning

As the nature of the research question is wicked, the planning needed to be revised with more detail to adapt to the project as the project progressed. We had planned to develop the guidelines for two weeks before starting the conceptualization. However, we felt during the first week of creating guidelines that we wanted to start with the concept development earlier than planned. We experienced difficulties in outlining the first version of the guidelines when we did not have any game concepts to which we could apply them. It was difficult to know which guidelines that were relevant to add to the draft. By creating a first version of the concepts however, we would get concrete concepts to have as examples when compiling the first draft of the guidelines. As such, we began a week earlier with the concepts which was really helpful for us. We got concrete examples which we could use discuss around which made it easier to filter out appropriate guidelines from the research and it became more clear what the consent should be like.

Previously, we had planned to have recurring feedback sessions with Global Services to get feedback on the guidelines and meetings with our supervisor at Ericsson to get feedback on game concepts. At this point in the project, we decided dates and more specifically how they were going to be carried out. The guidelines and game concepts were going to be developed in an iterative manner by getting feedback on each of them every other week. In this way, the concepts will change the guidelines in one iteration, and in the next the concepts will be revised based on the new set of guidelines. Hence, the concepts and guidelines will be constantly tested and improved throughout the project.

We wanted to include the employees at Packet Core in the development, i.e. participatory design, and therefore planned to conduct a workshop. The workshop would provide us with

the opportunity to present our ideas and get their feedback. The date for the workshop was decided and an invitation was sent out to the participants. We saw the workshop as a good way of introducing the concepts to the employees before starting with the recurring feedback session, and thus, we planned the workshop to be conducted prior to the feedback sessions. The writing of the report was postponed during this time due to time constraints. Furthermore, we were asked to oppose to another master thesis and we therefore allocated time for that activity during the upcoming weeks.

To correspond to the new plan, the Gantt chart was revised to the one shown in figure 6.6.

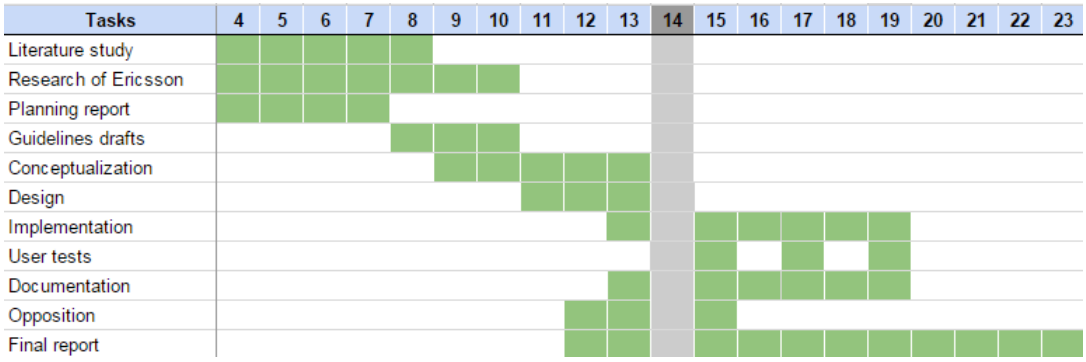

Figure 6.6: The third version of the Gantt chart. The columns represent week numbers.

6.4 First iteration of concepts

After the pre-study was completed and three courses chosen, we began to work with the game concepts in a first iteration. We carried out several brainstorming sessions for each course to come up with as many ideas as we could. Figure 6.7 shows the result from one of the sessions.

Figure 6.7: Post-it notes with ideas elicited from a brainstorming session

We first had some difficulty proceeding with the concept development. To aid in our work, we applied several different tools. The six design steps from the Gamification design framework, see section 2.4, were used as a guide in the design process and mediated discussions about the target behaviors and target group. The questions about game design presented by Kapp (2012) were answered which helped frame the game and find its purpose, target group and learning objectives. By defining the learning objectives for each game, see section 2.11, both TLO and ELO, it became more clear what the game should contain. When the learning objectives were not clearly defined, it was difficult to come up with a theme and game mechanics, which was the issue we had with the conceptualization. However, when breaking down the TLO into several ELO, it became easier to find appropriate mechanics that conformed to the learning objective. The ELOs were also listed by their difficulty and the order in which they must be learned. To analyze the ELOs and make them more concrete, we created a diagram that matched possible game mechanics, type of learning and the type of knowledge with each ELO.

Another possible reason for having trouble progressing with the conceptualization is that we had insufficient information about the domain. We learned a lot about the telecommunication network during the pre-study, but we still felt that we were missing information about the network nodes when developing. When not understanding a node's functionality exactly it was difficult to construct game mechanics around its features. We continuously asked our supervisor at Ericsson to explain functionality of nodes and networks when it was needed during the development. The importance of understanding the domain knowledge before commencing

the design was transformed into a guideline.

Deciding on the game genre also helped in the development of the game concepts, and was added to the guidelines. In this way, the conceptualization and design could be focus on a certain type of game and its mechanics. By using the MDA framework, it was easier to see how mechanics affected the dynamics and aesthetics of the game. Likewise, the framework aided in finding mechanics to achieve certain aesthetics.

6.4.1 Result from the brainstorming sessions

The brainstorming sessions elicited 15 concrete ideas of game concepts. We chose to take a lot of inspiration from other games. Instead of us, as unexperienced game designers, trying to come up with working game ideas, we based much of our games on existing games. We found inspiration from the games developed by Ericsson, namely Technology for Good, Order to Cash and Export Ernie 2. These games had been developed for learning purposes by experienced designers and were therefore appropriate to use has a source of inspiration. The game concepts we came up with are also based on the research found during the pre-study about what to consider when designing games and how other games are designed.

After the brainstorming session, we applied KJ analysis and ranked which ideas we thought would work well at Ericsson and work well for the target group. Some of the ideas that arose during the sessions were not applicable to the courses. One idea was to create an application in which people gain reputation by answering questions that other people come by and ask. We had some ideas of pervasive games, for example learning the name of all the rooms in the Ericsson building, but they did not fit with the courses. There were also ideas that we did not consider to be learning games in the beginning. For instance, a quiz game with questions related to a course and the learner was able to play against other people and even post questions themselves. Also, we did not consider these to be motivating enough and they were appropriate for the courses.

We also had the idea of using allegories to describe content came up. We felt that there are a lot of difficult concepts to grasp as a new employee at Ericsson. We thought that having allegories could make it easier to understand abstract knowledge when the learner can see it in a different context. Kapp (2013*b*) consider using allegories as a way to make it easier for the learner to grasp the information. For example, we had an idea of illustrating the data flow and the network nodes' functions with water flowing through lakes, rivers and dams. After receiving feedback on a couple of those types of ideas we realized that they might not work as well at Packet Core as we thought. By using allegories we separate the functionality of Ericsson's products from reality, when we actually should portray the reality. Employees, especially the newly hired, need to know how the technology is related to the reality since they are going to work with it. We have also realized that to understand the allegory, the learner might need to have knowledge about the content beforehand. Thus, an allegory is only effective for those people who already hold knowledge about the subject, which is not what the game should be about. The feedback also gave us the impression that people thought the allegory ideas were childish

and unserious.

After some time was spent on the conceptualizing for the network overview and VoLTE courses, we chose to put lower priority on the IoT course. The main reason for this was time constraints. Even though we had a few ideas after having carried out two brainstorming session focused the IoT course, we realized that we would not have time to continue developing them. The goal was also to design games for different level of knowledge, and IoT belonged to high level knowledge which we already had covered with the network overview course.

The 15 ideas that arose during the brainstorming session were the following:

- Save the City
- Super Packet
- Nodify
- Call of VoLTE
- The wall
- Find competence
- Find a room
- Find nodes
- Ericsson quiz
- Gamify the learning process at Ericsson
- Water network
- Network body
- Be the packet
- Network simulator
- Hexagons

A complete list of the ideas with descriptive text can be found in Appendix D. Out of the 15 ideas, four of them were chosen to be further developed, namely Save the City, Super Packet, Nodify and Call of VoLTE.

While putting the IoT course aside, we also designed one additional concept for the overview course, resulting in a total of four concepts instead of three which we initially planned. Hence, we developed three concepts for the overview course and one concept for the VoLTE course. The reason for designing more concepts for the overview course was that we found several concepts for the overview interesting and we saw a potential in developing them further. Another reason was that we did not possess nor did have enough time to learn all in-depth technical knowledge which was needed to design games for the VoLTE course. We did attend a presentation about VoLTE and asked a lot of questions about it during interviews. However, we got

to an adequate level of knowledge faster for the overview course at which it was possible to design games for the course. Hence, more concepts were produced for the overview course compared to the VoLTE course.

Below follows a description of the first version of the games for the overview and VoLTE course.

6.4.2 First version of overview course

We began by developing the game concept for the overview course. We defined the target group and learning objectives for the course. The target group was decided to be new employees at Packet Core and other Ericsson employees who do not have any previous knowledge about the Packet Core nodes.

The Terminal Learning Objective (TLO) was defined as:

- Learn the overview of Ericsson Packet Core

And the Enabling Learning Objectives (ELOs) were defined as:

- Understand the similarities and differences between the 2G (GSM), 3G (WCDMA) and 4G (LTE) networks
- Identify the difference between voice and data transfer networks
- Identify and understand the nodes' functions in the Packet Core Network
- Identify and understand the relationships between the nodes
- Build a Packet Core Network of nodes and relationships

The first version of the game concepts were the following:

- Save the City
- Super Packet
- Nodify

6.4.2.1 Save the City

Save the City is a serious game in which the learner should build a telecommunication network in a city by placing and connecting nodes on a map. The learner should keep the population satisfied by correctly building the network. The image of the city is taken from the game Technology for Good.

The story is that the learner, as an Ericsson employee, comes to a city which has working 2G voice network and is in need of a data network. The goal is to build a data network for 2G, 3G and 4G. Two characters exist in the game, the city's mayor and a mentor. The mayor has

needs, e.g. “My town needs Internet” and the mentor turn those needs into objectives, e.g. “Build a 2G data network”. The mentor gives explanations when needed but the learner has to read the information available for each node and place them on the map. The knowledge is assessed by placing the nodes. The nodes cost money to build and money is earned when there is a working network in the city. The satisfaction changes depending on the learner’s performance. The learner earns badges when completing the objectives.

The first sketch that was made of the game is displayed in figure 6.8.

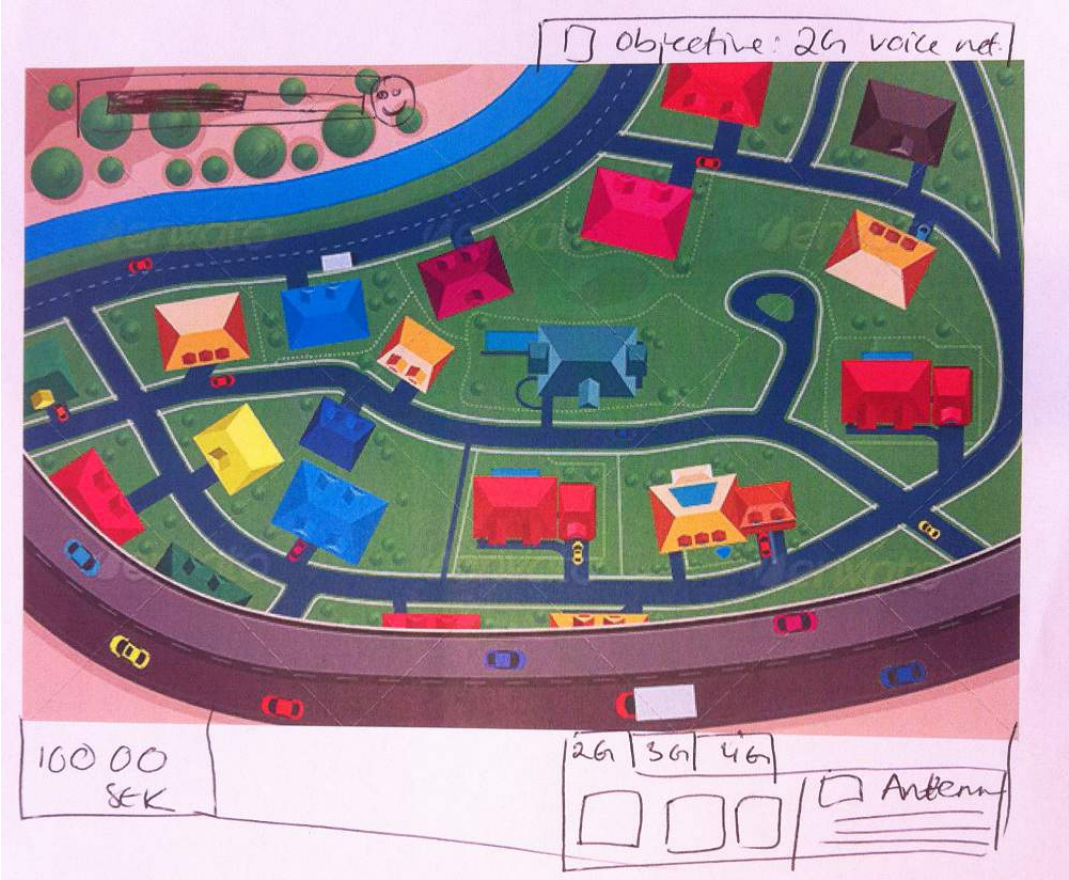

Figure 6.8: A first sketch of Save the City was made to get a sense of the gameplay.

To make the game idea more concrete, a flowchart was created to illustrate the order in which the ELOs should be learned, as recommended by (Kapp 2013*b*). This made it easier for us to get an overview of the objectives. The flowchart was used to create a story for the game that would run in parallel with the objectives. This made it much easier to extract a scenario that corresponded to the learning objectives and the order in which they should be learned. The scenario made the game more concrete and helped us in outlining more details when put on paper. Each arrow in the flowchart more or less created a change of level in the game. Moving

from one learning objective to the next was made clear by switching to the next level. After seeing the benefit of applying these methods, we created guidelines for each of them to help in the development of games in the future. The scenario was first created on a whiteboard, shown in figure 6.9, and which was later transferred into images of the game.

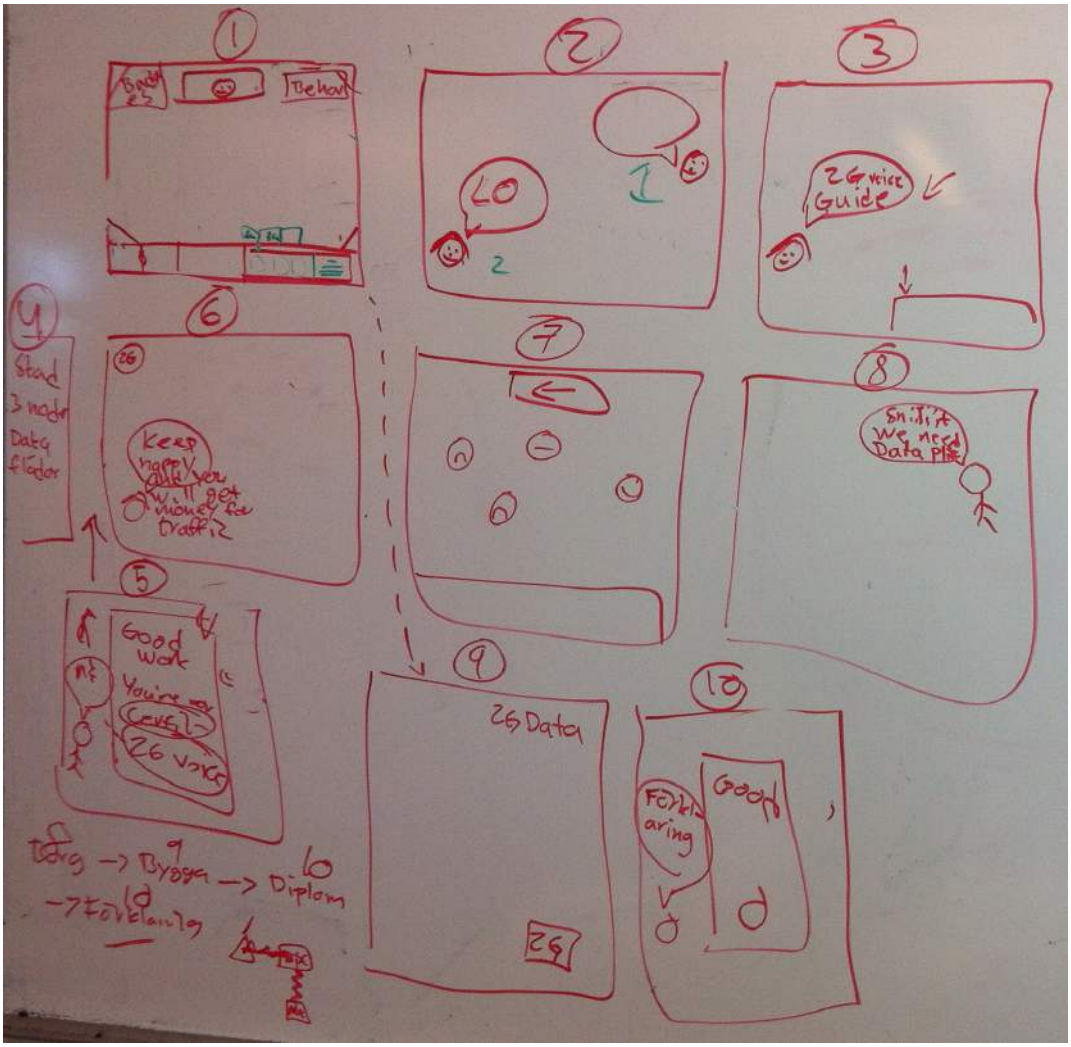

Figure 6.9: The first scenario created on a whiteboard.

The following images show the scenario that was created for the game. The scenario begins with showing the existing 2G voice network, and then the mayor appears to express his needs.

This image shows antennas and masts which are placed in the city. The satisfaction bar is shown in the top right corner and the money in the bottom left corner. In the bottom right corner are the nodes placed which are available to build for each network, accompanied with

a description.

Figure 6.10: The first image in the scenario showing the city and the interface. The first thing that happens is that the mayor states his needs.

Figure 6.11: The mayor states the needs of the city.

Figure 6.12: The mentor states the objective. The mentor transforms the need, stated by the mayor into an objective. The objective is then shown and the learner can start to build.

Figure 6.13: A node is placed correctly and is connected to the network. When the learner has placed the correct node and connected with right node, its border turns blue and the connection is visualized by signals that flow through the connected nodes.

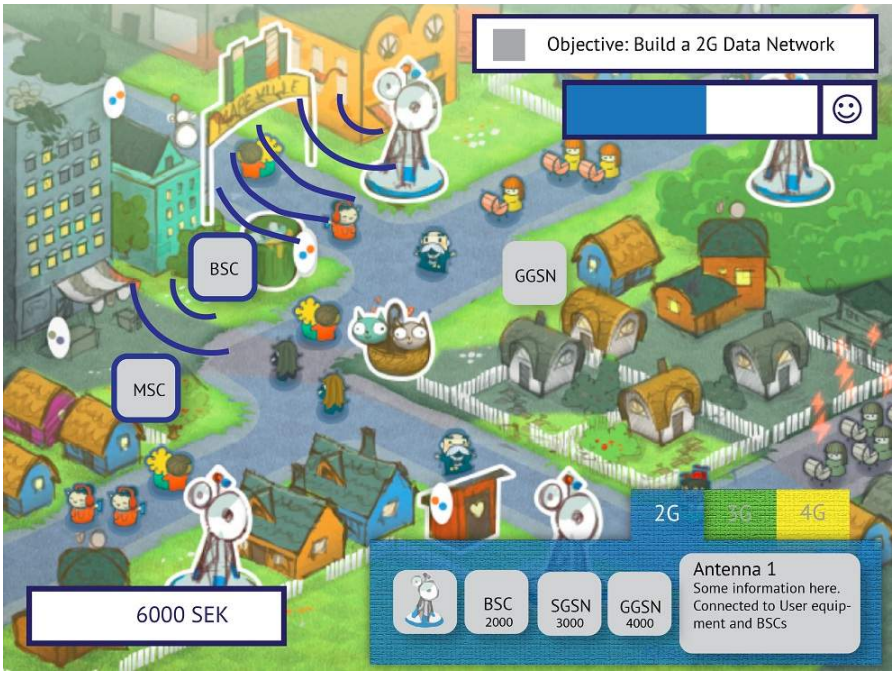

Figure 6.14: A node is placed incorrectly and is not connected to the network.

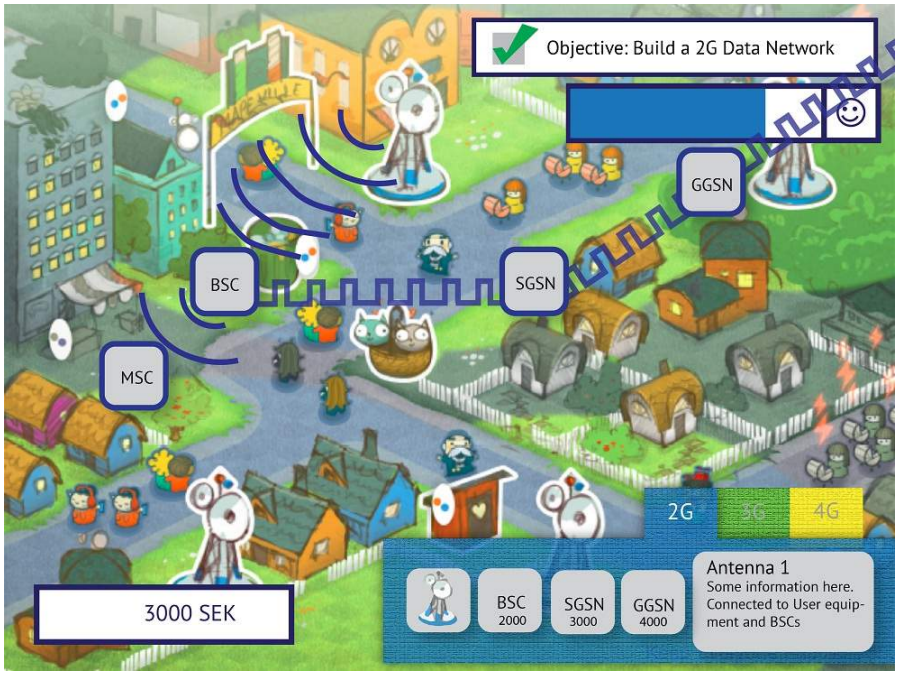

Figure 6.15: Placing and connecting the last node correctly completes the objective.

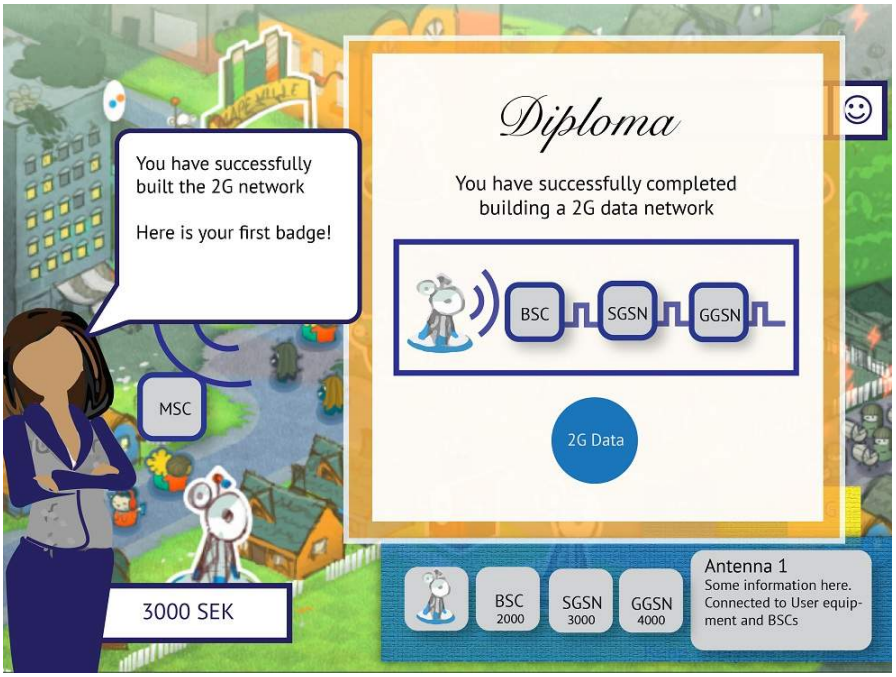

Figure 6.16: The learner is awarded a certificate and a badge. The certificate shows the network which was built. The learner also earns a badge, either gold, silver or bronze.

Figure 6.17: Badge is shown in the top left corner and the mentor gives an explanation and the learner gets money for building a network.

Save the City takes a lot of inspiration from Technology for Good described in 3. We also wanted to design a game that to some extent used in figure 6.1 which we were presented to in the beginning of the project, since this image was often used when describing the network.

Order to Cash and Export Ernie 2 are based on prompting the learner with multiple choice questions about the content. After seeing how the game was designed, we tried to minimize the use of multiple choice questions in our game concepts. This was also transformed into a guideline. Instead of answering questions, we wanted to design a game in which the knowledge assessment is performed through the use of game mechanics, as in Equalize. Save the City is designed to assess that the learner has understood the knowledge by confirming the placement of nodes. This will also make the learner act on the knowledge gained by playing the game, which Kapp (2013*b*) considers desirable.

6.4.2.2 Super Packet

Super Packet is a serious game and a platform game in which the learner controls a data packet throughout the telecommunication network, from the user equipment to the Internet. We got the idea of incorporating the demo wall, see chapter 3, into a game concept during the brainstorming sessions. As such, the map in the game looks like the demo wall.

Each node contains platforms which the learner can jump on. The idea is that the map should illustrate the nodes' functions by the placement of platforms and other elements the learner can interact with. Information of each node will be displayed as text in the background. The learner must either act on the information or read it while waiting for some event to happen. The learner can collect ones (1) and zeros (0) to gain points. The data packet has a Time To Live (TTL) (the lifetime of data in a network) which is decreasing and the learner has to reach a checkpoint to get more time. If the time runs out, the learner loses. The learner can choose different types of packet, such as music, surf or stream. The map could change depending on the type and its priority in the network. Several sketches of the game were made to explain and present the game idea which can seen in figures figs. 6.18 to 6.20

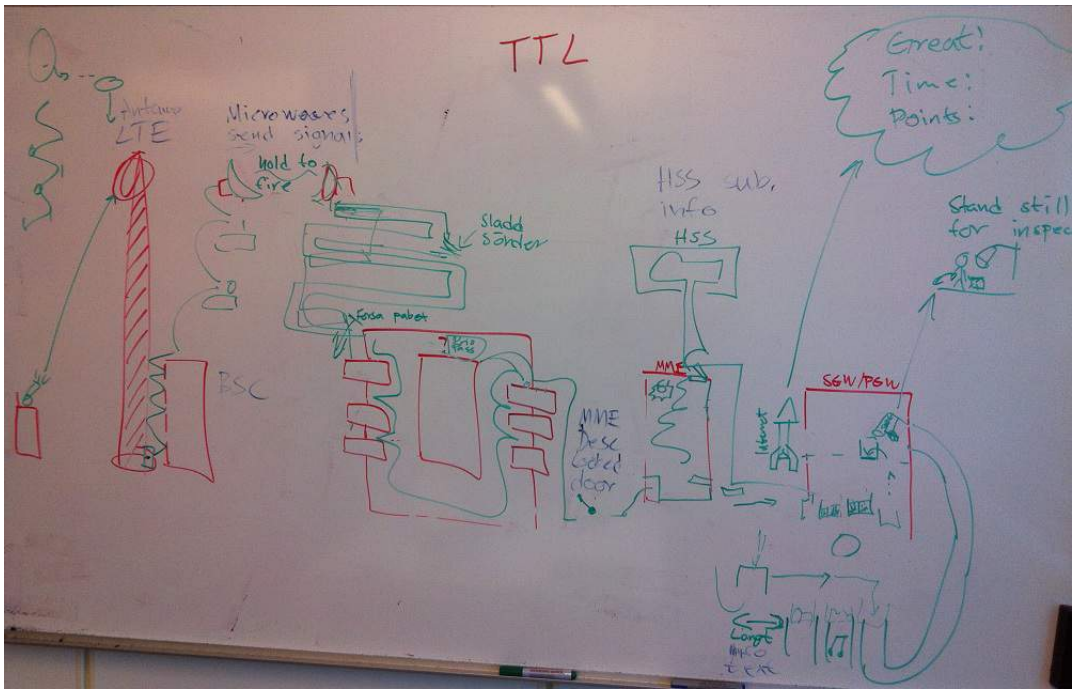

Figure 6.18: A first sketch of the game idea Super Packet created on a whiteboard. It represents map of the platforms based on the functions of the different nodes in a 4G network.

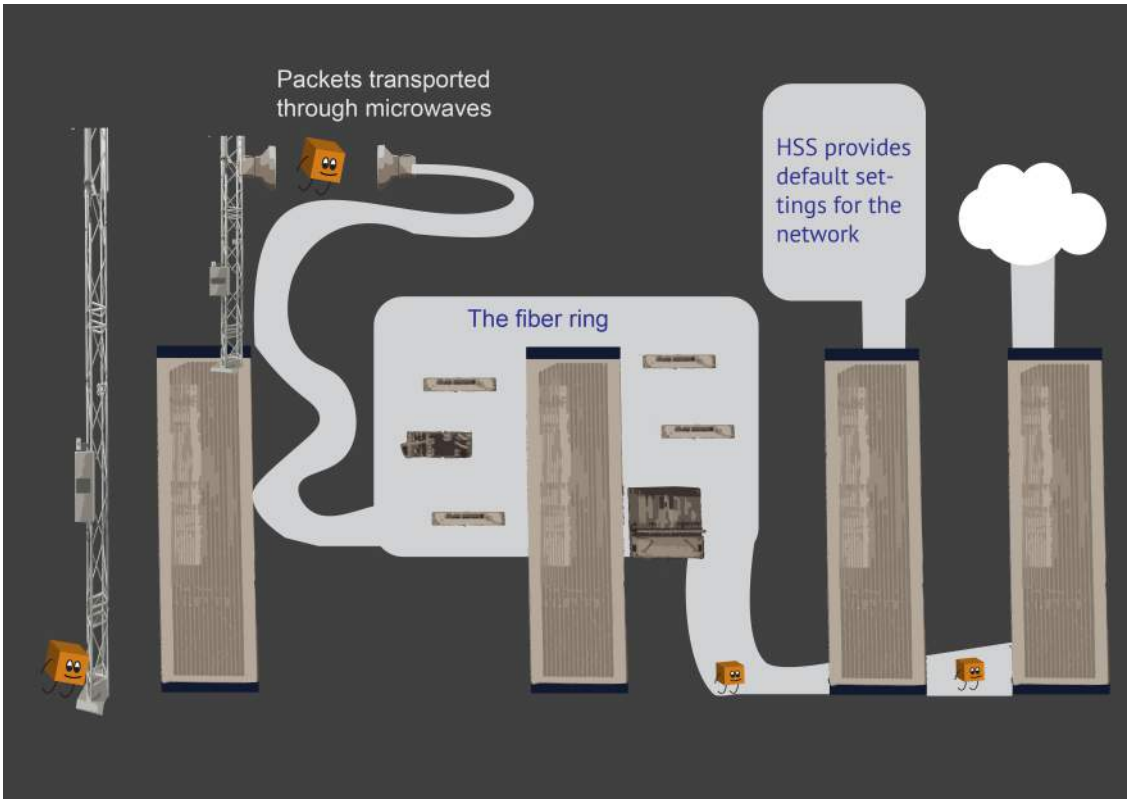

Figure 6.19: The complete map of the game based on a photograph of the demo wall.

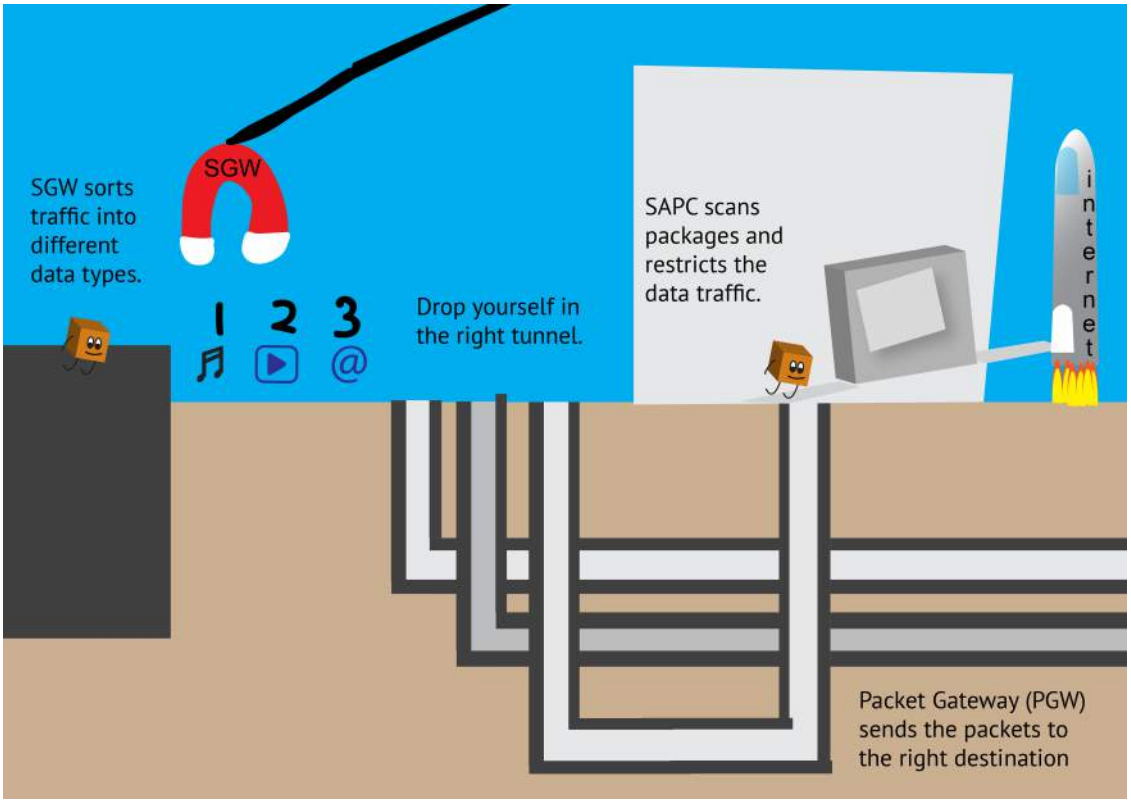

Figure 6.20: The game will zoom in to show more detail of the node. This image illustrates the node which is responsible for sorting the packets. The learner needs to read the text while playing in order to succeed in the game.

The inspiration for Super Packet came from Export Ernie 2 and Equalize. Export Ernie 2 does however contain a lot of text that the learner should read. We tried to avoid that as well because reading long descriptions while playing will interrupt the gameplay and can possibly make the learner bored. The learner also becomes inactive when reading, which contradicts one of the guidelines. Instead, we tried to design the game as Equalize which contains less text and the text can be seen in the background of the game so that the learner can read while playing. In that way, the learner is not interrupted by a textbox to read before proceeding.

6.4.2.3 Nodify

Nodify is a collection of smaller serious games, one for each network node. Each game illustrates the function of a node. The nodes' main function is illustrated in a way which is different from reality to help the player remember. Points are calculated separately for each game. Each mini game in Nodify is very much based around the games in Lumosity and also Flight Control.

We created sketches on whiteboard at first (see figure 6.21.

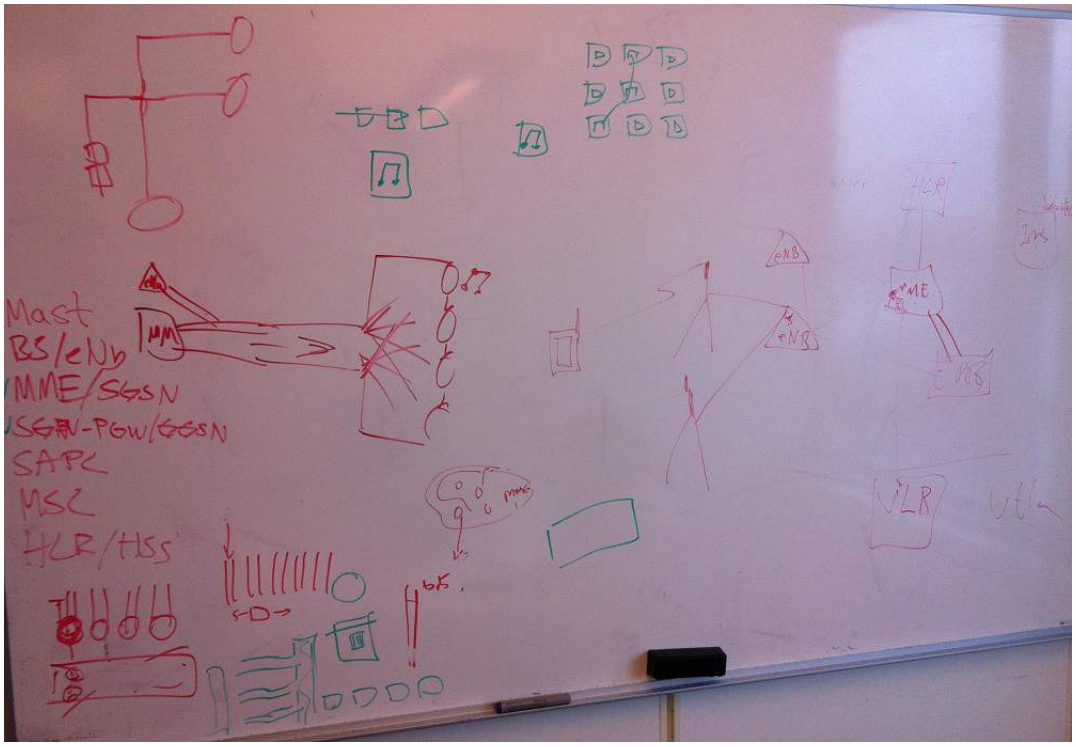

Figure 6.21: Sketches of mini games that illustrate the nodes' functions.

In figures in figs. 6.22 and 6.23, Two alternatives were created for a node which sorts packets. In these games, the learner controls the path of packets so they end up in the correct location. Figure 6.24 is a sketch of the game that illustrate the function of a node which keeps track of which antenna the user equipment is connected to.

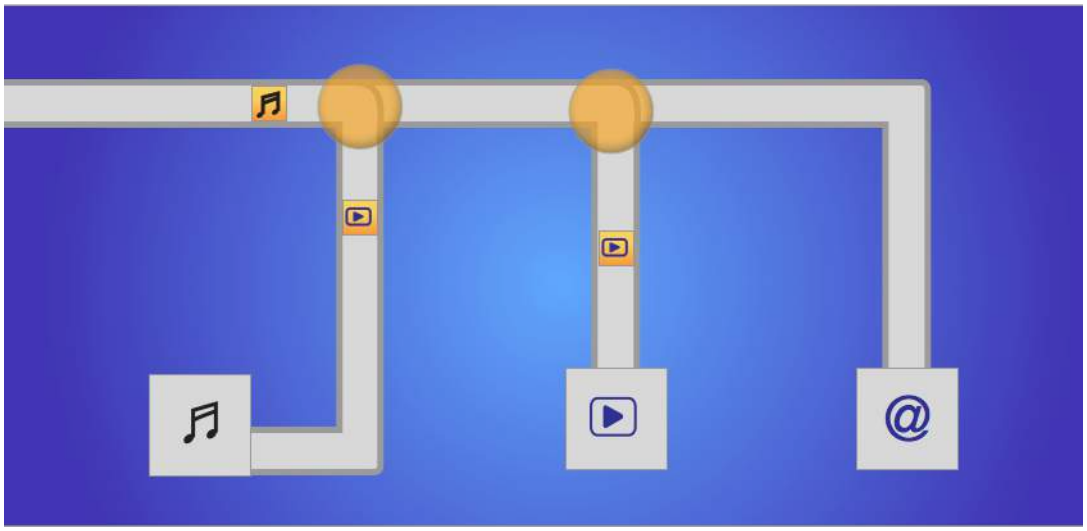

Figure 6.22: The learner can control the direction of the packets by clicking on the orange circles.

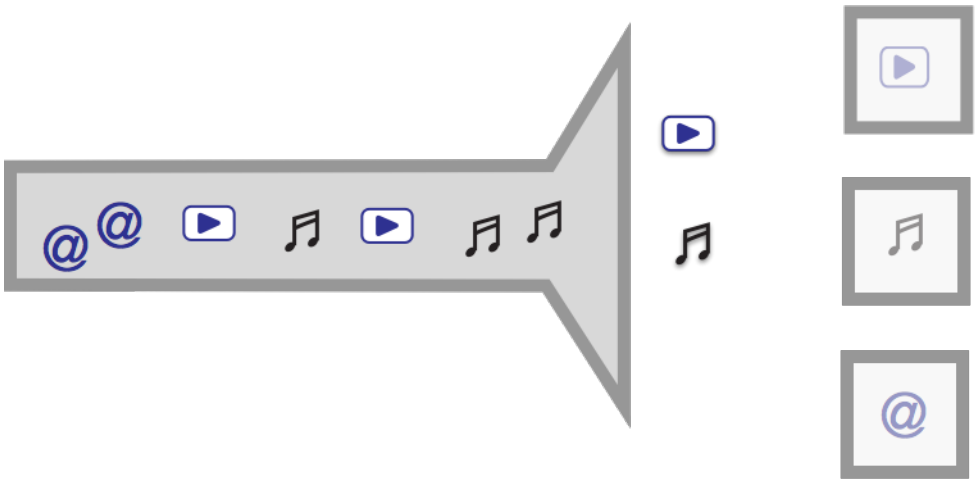

Figure 6.23: The learner can drag the packets to the correct location as they leave the rectangle.

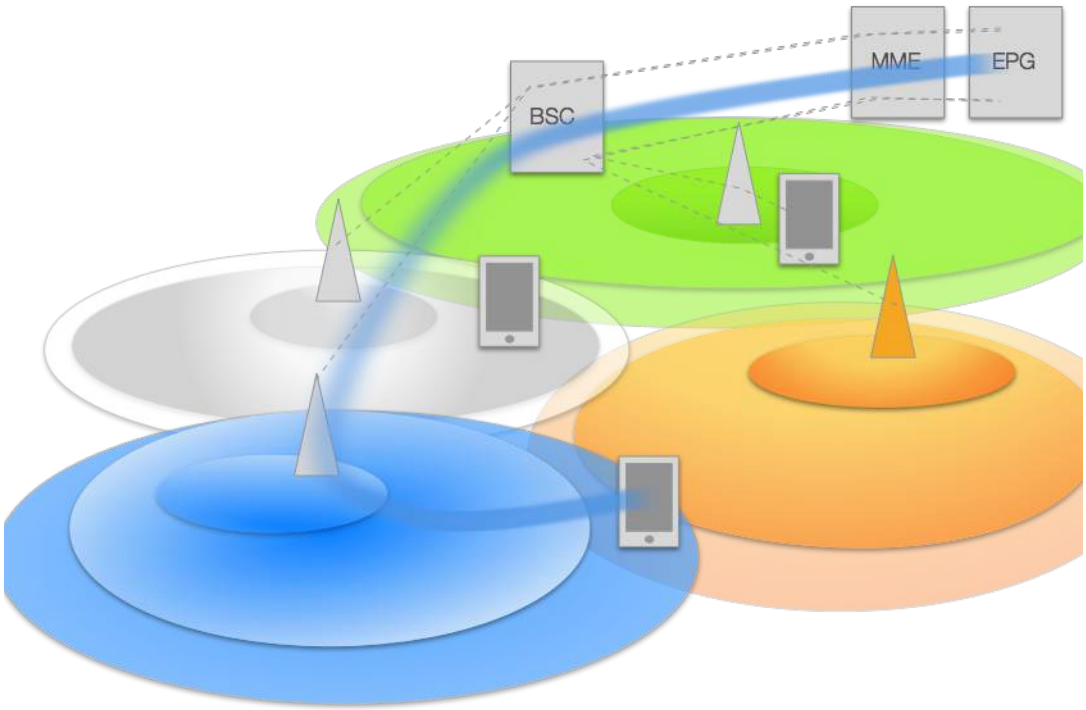

Figure 6.24: This image is for a node in which one of its functions is to keep track of in which antenna the user equipment is connected to. In this mini game, when an user equipment moves into a new antenna, the learner can drag a line from it to the node so that it tracks the location.

6.4.3 First version of VoLTE course

After developing game concept for the overview course, we started with the VoLTE course. The target group was decided to be people with previous knowledge about the Packet Core nodes who attend a course about VoLTE.

The TLO was defined as:

- Learn the VoLTE use cases: VoLTE call, SRVCC, Emergency and Priority

And the ELOs were defined as:

- Identify and understand the nodes' functions in the VoLTE use cases
- Identify and understand the relationships between the nodes
- Understand how the network switch between the 3G (WCDMA) and 4G (LTE) networks
- Identify and understand the role of the IMS and User Equipment in the network

- Understand the difference between a call over the Circuit Switch Network and over LTE

The first version of the game concept for the VoLTE course:

- Call of VoLTE

6.4.3.1 Call of VoLTE

Call of VoLTE is a gamification of a sequence diagram in which the learner controls several characters up and down on the vertical lines within a diagram. The characters should be placed at the location where two signals meet to forward the signal over the line. Signals are constantly flowing through the diagram so the learner must place a character at a location when a signal reaches it. Points are rewarded by forwarding signals and if the learner misses a call, one life is lost. When 3 lives are depleted, the learner loses.

Figure 6.25 shows a sequence diagram is made as a sketch to illustrate the gameplay. The user equipment sends a signal and then moves to the bottom of the screen. The characters can be moved up and down on the colored lines to forward signals.

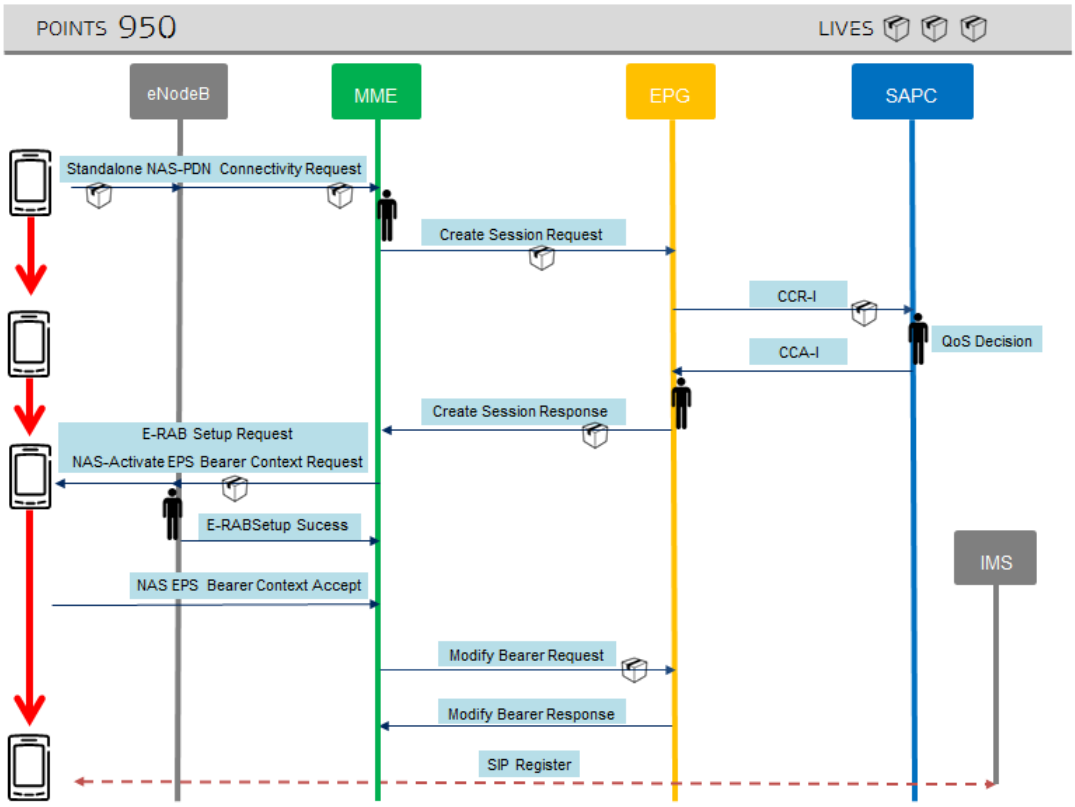

Figure 6.25: A sketch of the game idea Call of VoLTE. The characters in the game can be moved up and down on the colored lines to forward signals represented by the boxes.

Export Ernie 2 does not, in our opinion, contain enough game mechanics to motivate the learner to perform well in the game and to continue playing. The learner can just click through the questions without getting a single correct answer and without losing anything by doing so. Our guidelines state that the game should punish the learner to some extent, hence promoting the learner to read the content. Also, there are no game mechanics in Export Ernie 2 which motivates the learner to perform well while playing. The points are shown in the end which makes is difficult to make corrections during the game to perform better. We tried to include mechanics in our games that triggers the learner while playing. In Call of VoLTE, points and stars are added and visible when playing. Furthermore, to motivate the learner, Save the City incorporates a satisfaction bar that has to be kept at a certain level, and Super Packet uses a time limit.

6.5 Second iteration of guidelines

The first version of the guidelines document which identified areas of interest was in this iteration revised to guidelines with a title that encompassed the essence of the guideline. For example, 'Goals and Challenges' and 'Game Levels' were changed to 'Incorporate several goals and challenges' and 'Divide content into levels'. Most of the titles were changed in this way to have a more prescriptive title. Some areas were merged and we added another group which was named 'Pre-design'. The other groups, 'Game Design', 'Designing Content for Learning', 'Motivation' and 'Game Aesthetics' remained. However, 'Designing Content for Learning' was changed to 'Designing for Learning'. Refer to Appendix B for the complete guidelines document for this iteration.

Below each title was a more detailed description of the guideline. We chose to use the word 'learner' instead of 'player' to emphasize on the development of a learning game, and not an entertainment game. The structure was changed and based partly on the one from the Game Ontology Project and the Component Framework. We also had ideas of structuring the guidelines to match the design process, i.e. the ones used in the beginning of the design were placed at the top. However, we decided it was easier to find guidelines if they were sorted based on their use and not when to apply them in time.

When developing the game concepts further, different tools were applied which not only helped with the concepts, but also reshaped the guidelines. Examples of these were the use of the questions presented by Kapp (2013*b*) for game design and defining learning objectives. When we saw how these tools helped in the conceptualization, it became natural to adapt the guidelines to include those as well. We did not however include every single of Kapp's questions, but extracted the ones that we thought were important and made use of ourselves. These were added to the new group 'Pre-design'.

Applying the guidelines to game concepts made us reflect over their use and relevance. We thought about how they could be utilized in game design at Ericsson and which of them we used in our own development. For each game concept, we went through the list of guidelines and marked which of them the game incorporated. In that way, we could analyze which

guidelines were used the most and which were not used at all, and thereby changing them to be more focused on what is really relevant. We did not have any feedback sessions with Global Services during the first iteration. The changes we made to this draft were governed by the game concepts development.

6.6 Feedback workshop

As planned, we conducted a workshop with the employees at Packet Core. The word workshop was chosen because it was a familiar term for the employees because they were themselves organizing workshops with similar setup, not with the same purpose however. The workshop gave us the opportunity to present and get feedback on the game ideas developed in the first iteration. As such, we used the game ideas as mediating tools, section 4.4.2, to stimulate the discussion and enable the participants to provide hands-on comments.

The invitation including the agenda for the hour long workshop was sent out two weeks in advance to thirteen employees. Seven of them were able to participate in the session, excluding the two of us. The goal was to include the employees in the development and take advantage of their domain specific knowledge to develop the game concepts. Rogers et al. (2011) argues that involving the users throughout the development process will make them more keen to use the product when it is completed. We also saw it as opportunity to inform more employees about the thesis project, including its goals and purpose. The goal was not to come up with any new game concepts. The concepts for the overview course and the VoLTE course were chosen to be the topic of the workshop since the participants had knowledge about these areas.

Descriptions and a scenario of images and sketches were compiled for each game idea before the workshop. Creating these documents and images made us think through the games in a more detailed manner and helped us find problems that existed.

Four questions were printed on paper and handed to the participants at the start of the session. The purpose with the questions was to limit the discussion to what we wanted to achieve with the workshop. The questions were:

- How should the nodes' main functions be incorporated into the game concepts? How could these be illustrated?
- What works and what does not work with the game concepts?
- Is the main function of each node described correctly? Are there other important or distinguishable functions that could be incorporated into a game concept?
- Are there additional learning objectives that should be included for each course?

6.6.1 Planning the workshop

The workshop was began with a short presentation of the thesis project and the four game concepts, which we planned to last for about fifteen minutes. The learning objectives for each course were presented as well as a list of the network nodes' main function. Each concept had a description, scenario and a few sketches explaining the gameplay. These were also printed on A4 papers and put on whiteboards in a conference room, shown in figures figs. 6.26 to 6.28. Empty space was left around the papers of each idea to allow the participants to draw or write something on the whiteboard. The plan was to have the participants walk around freely in the room and discuss the game concepts with each other. They were given a pen and a stack of post-it notes to take notes and put them on the wall next to the papers. Whiteboard pens were also available if anyone wanted to use the boards. We were meant to take part in the discussion when needed, but mainly take notes of what the participants said.

Images showing the setup for the workshop.

Figure 6.26: Description and sketches of Super Packet and Nodify used in the feedback workshop.

Figure 6.27: Description and sketches of Save the City

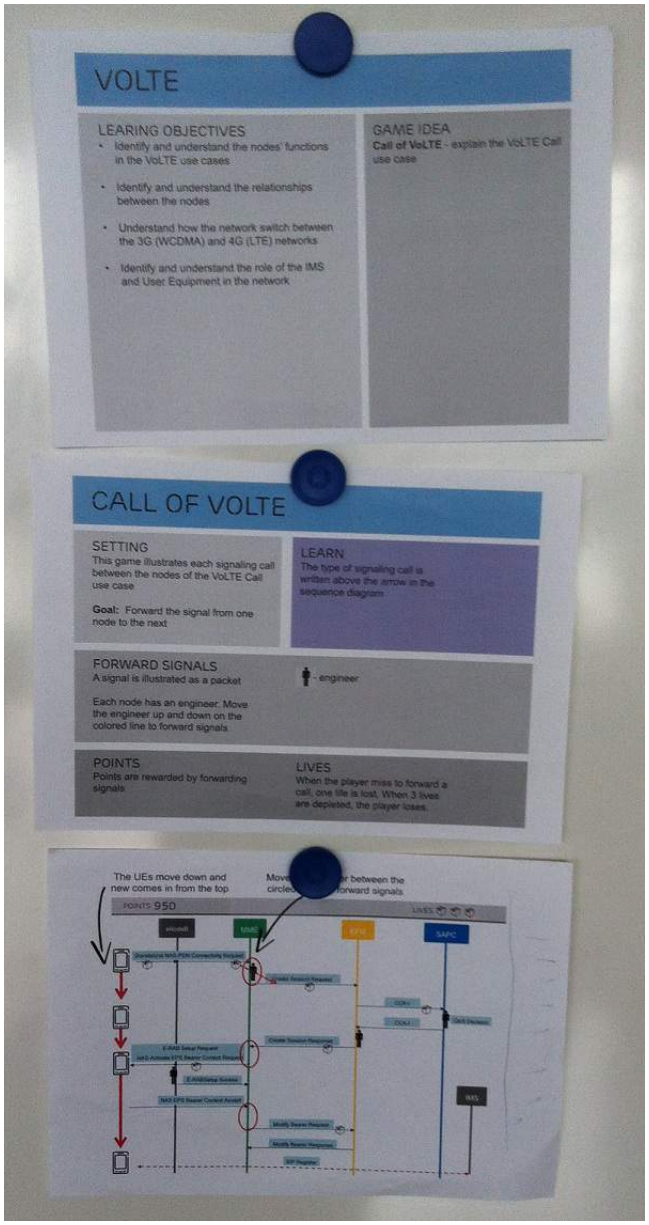

Figure 6.28: Description and sketches of Call of VoLTE

6.6.2 Result of the workshop

The workshop turned out different than planned. The presentation of the game concepts triggered a lot of discussion among the participants and therefore lasted the whole hour. Because of this, there was no time for the participants to walk around freely and give feedback on the concepts. The format became more like a focus group, which was to our advantage because

of the use of mediating tools which enable focus group participants to express more valuable information (Engelbrektsson et al. 2000). The discussion did cover the goal and the questions for the workshop, so the information received was still similar to what we aimed at, not to the same extent however. Everyone present at the workshop was open to help and gave a lot of constructive feedback. They expressed positive comments about the games in general and saw a use of them at Packet Core. A side-goal was also to inform the employees about the game ideas and we achieved this goal through the presentation the ideas during the workshop.

When the game concept for the VoLTE call use case was presented, the participants pointed out that it was incorrect. The game concept was supposed to describe a sequence diagram containing signals that were sent during the use case. However, the sequence diagram did not belong to the actual use case, but was a part of a previous step in the network initiation. Despite this issue, the participants believed that the game concept could be used to describe any type of sequence diagram, not only for VoLTE use cases.

The workshop gave insights into the fact that not only games that teach is suitable for internal training at Packet Core, but also games that test knowledge. Some of the game ideas that arose during the session were games that proposed questions or in other ways required the learner to have knowledge about the content beforehand. These types of games would be suitable to play after attending an internal course to repeat the content. Before the workshop we had not considered test games to meet the goals of the project. As mentioned earlier, we disregarded game ideas we got during the brainstorming sessions because they were not focused on learning and not motivating enough for the learner. After the workshop however we realized the need and potential of test games for internal training at Packet Core. Since testing is part of the training, games with that purpose can make it more interesting and engaging. Kapp (2013*b*) also makes the distinction between test and teaching games and points out that both of them provide learning opportunities. This distinction was incorporated into the guidelines and came to be important for the rest of the concept development. Call of VoLTE was changed into one of the game ideas that arose during the workshop, see explanation in the next section.

6.7 Second iteration of concepts

The majority of comments that we received during the workshop were concerning the game Call of VoLTE. As mentioned above, we realized the possibility of creating testing games and changed Call of VoLTE based on that. The game was also criticized because too much focus was on moving the character on the line and not actually reading the signals so they could be learned. We therefore saw the need to change the game and made so according to one of the ideas that arose during the workshop, which transformed the game into a testing game.

Call of VoLTE changed to a game where signals were falling from top to bottom at the right side of the screen which can be seen in figure 6.29. The learner can drag and drop the signals to the correct location in the sequence diagram before they reach the bottom of the screen. This requires the learner to have some previous knowledge about the use case to be able to place the signals at the location where they belong. However, the learner can also learn through

the game by making mistakes and trying again with a new signal. The controllable characters were removed completely from the game.

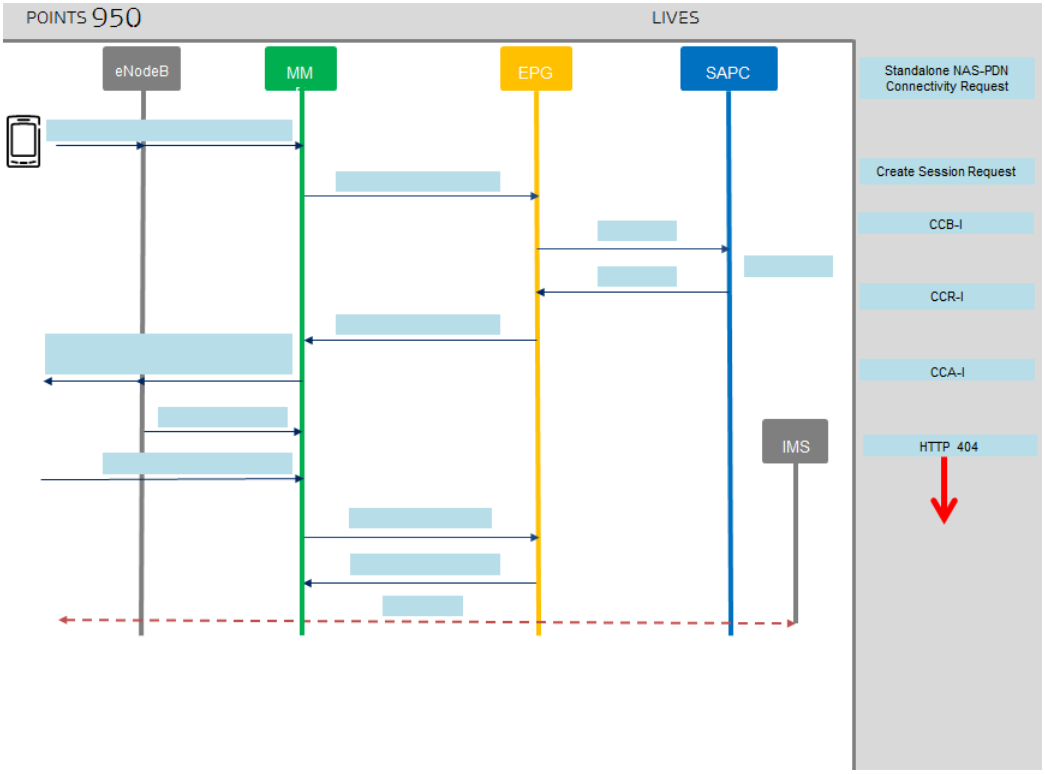

Figure 6.29: The second version of Call of VolTE in which the learner can drag and drop the signals to the correct location. Signals on the right hand moves down in the direction of the arrow.

In the first iteration we also received feedback on the games from Global Services. We were not only presenting the guidelines to them but also the games because they could come with valuable comments since they are experienced designers. They were very positive about the games and confirmed many ideas that we had about the design. Many of the comments we received had already been discussed during the first iteration. It felt reassuring that they, as experienced designers, agreed with many of the design decision that we had made and made us continue pursuing these ideas.

6.8 Workshop follow-up

To gain more extensive feedback on each game concept, we decided to follow up the workshop with several sessions of group feedback. Everyone who participated at the workshop (and a few additional employees) were divided into groups of two or three and given one or two game

concepts to give feedback on. Information about each concept, structured the same as for the workshop, was sent to the groups. They were then asked to discuss the concepts and then meet us to present their feedback. Four interviews were carried out, one interview for each concept.

These sessions gave additional feedback on game concepts and most importantly, we realized the importance of context. Instead of focusing on one network node at the time, which Nodify did, they wanted to have an end-to-end perspective of the network. In other words, follow a signal from the mobile phone all the way through the network to the Internet, including calls that are made and parameters that are set. Super Packet was designed to do just that and did therefore gain positive feedback during the sessions. It made us feel more sure about developing this game further. The importance of putting the learning into a context was also turned into a guideline.

Packet Core is today using the end-to-end perspective when explaining new concepts, in a so called Use Case. A use case describes a sequence of signals with parameters that occur in the network when, for example, the phone connects to the Internet. A employee did express during one of the sessions that "learning from a use case helps putting the knowledge into a context". Using this reasoning, we began to use the term 'use case' in the games and to focus more on its perspective when designing.

6.9 Third replanning

After the distinction between testing and teaching games became apparent, we realized that the research question needed to be changed. We did not know from the beginning which direction the project was going to take, and 'game-based learning' was used because it was found early in the pre-study as an umbrella term. It contained the word 'learning' which to some extent exclude testing games. The research question was changed to use the term 'game' instead of 'game-based learning' to also include testing games:

How can games be implemented at Ericsson Packet Core for training purposes?

Again, because of the research question being a wicked problem, we needed to revise the planning. When arriving at this point in the project, we decided the plan in more detail for the remaining time. There were six more activities that needed to be performed:

- Revise the game concepts after feedback we had received.
- Compile one more draft and one final version of the guidelines.
- Create a description for all other game ideas which we did not choose to develop.
- Create a paper prototype for one of the games and test it.
- Finish the report.
- Prepare presentations.

At this point, we discussed whether there was time for implementing a prototype in code as we initially had planned. Since this was the first time Packet Core decided to test games in training, we wanted to ensure that the game concepts were developed to such an extent that somebody else could just implement them. Therefore, we wanted to spend more time on developing all three ideas, and not focusing on one of them too early to make time for implementation. However, we wanted to create something that one could interact with to make it easier to explain the idea to others. To this end, we decided to create a paper prototype, which takes less time, to still have something that the employees can interact with and to be able to test a game. As we would not implement a game, the activity 'Documentation' was removed from the planning, which included documenting the source code. We also decided test the prototype once to save time instead of several times as we planned from the beginning. The Gantt chart was revised to include the more specific planning for the remaining time and can be seen in figure 6.30.

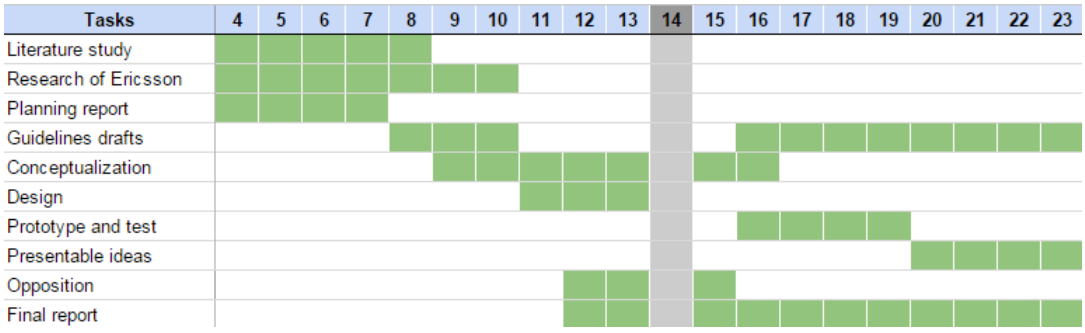

Figure 6.30: The fourth version of the Gantt chart.

6.10 Third iteration of guidelines

Feedback sessions were carried out with Global Services in the second iteration. We received feedback concerning the structure of the draft and that some of the guidelines were formulated vague. They also emphasized the importance of several guidelines which we had included. During the sessions we came to realize the importance of creating guidelines that are easy to use during a project. They should be structured in a way that reflects how they should be used when designing a game. During one of the sessions, the idea of having a checklist was proposed. A checklist would be a shorter version of the complete list of guidelines, with not as much details, and formatted to support the designer to check off those which are completed. We decide to look at our own development procedure to find a structure we think would be easy to use. We found that a checklist would definitely make it easier to keep track of completed and uncompleted guidelines.

Most of the guidelines' titles were kept the same, but the descriptions were revised to be more clear. After more development of the game ideas additional research gathered, the following guidelines were added: 'Make sure you have correct information', 'Decide whether to test or

teach', 'Create a scenario', 'Contextualize the learning experience', 'Divide content into levels', 'Try to avoid perfect communication', 'Player types' and 'Types of Fun'. 'Measure progress' was changed to 'Show progress'. Refer to Appendix C for the complete guidelines document for the third iteration.

6.11 Third iteration of concepts

After realizing the importance of providing a context for the learner, Nodify, which was designed to separately illustrate each network nodes' functions, was abandoned. It received negative feedback during the workshop follow-up and we decided to focus on the other ideas instead.

6.11.1 Save the city

A reason for continuing designing Save the City is that Kapp (2013*b*) recommends to design a "building game" when one should "teach learners how to put elements together to form coherent or functional whole", which is true for overview course. The course also teaches a lot of acronyms that are used daily at Ericsson, i.e. declarative knowledge, see section 2.11. Kapp (2012) argues that declarative knowledge, such as acronyms and jargon, is key to understand to be successful, especially for new employees. By creating a game that helps the learner acquire this knowledge provides a strong base for future learning (Kapp 2012). We decided to base the game around a story because when the information is presented through a story the learner can remember and apply the information better, compared to presenting it though a bulleted list (Enders 2013). Save the City was designed to have multiple levels to increase the odds that the learner will replay each level (Enders 2013). After each level, the learner is also rewarded with a badge of different values depending on the performance as an enticement to replay and perform better (Kapp 2014*a*, Chatfield 2010, Enders 2013). By playing a level several times, we hope the learner will understand some new knowledge and repeat it to hopefully remember it better.

Save the City was from the beginning a temporary name and was at this point in the project changed to EriSim which is a composition of the words Ericsson and Simulation.

6.11.2 Super Packet

Super Packet gained positive feedback during the workshop follow-up because it put the learner in a context and gave an end-to-end perspective of the network. The participants during the follow-up did however express a wish to add more detailed knowledge to the game, i.e. parameters and how they are sent between the nodes. This was because parameters are important to include to be able to understand the context of a use case and its result in the network. To this end, we redesigned the game so that the learner collects parameters throughout the map

and have to drop them off in the right node, thereby simulating how the parameters are sent between nodes in a use case. Since the focus became more centered on use case, we abandoned the idea of designing the map in each node to illustrating its functions. We also added enemies to make the game even more similar to a regular platform game, as in Equalize. The enemies now fill a purpose by guarding the parameters, compared to the previous version of the game.

This game also teaches the learner about acronyms, i.e. declarative knowledge, see section 2.11 which Kapp (2012) argues to be key to understand.

Super Packet was also a temporary name and was changed to eWall, referring to e-learning and the demo wall.

6.11.3 Call of VoLTE

When revising the game ideas after the workshop follow-up, we came up with an alternative to the drag and drop approach. The signals could, instead, pop up at a location in the sequence diagram, and the learner could either accept or discard the signals, depending on if it is placed correctly. By having the basic idea of gamifying a sequence diagram, other alternatives to the game were easily found, which shows the flexibility of the game concept and how the game idea could be used as a mediating tool. The basic idea of the game received a lot of positive feedback throughout the project. It showed the employees what was possible to do with a sequence diagram. The employees can also see a need to have such a game in their courses. As such, there is a lot of potential with the game which have been the driving force for pursuing this idea.

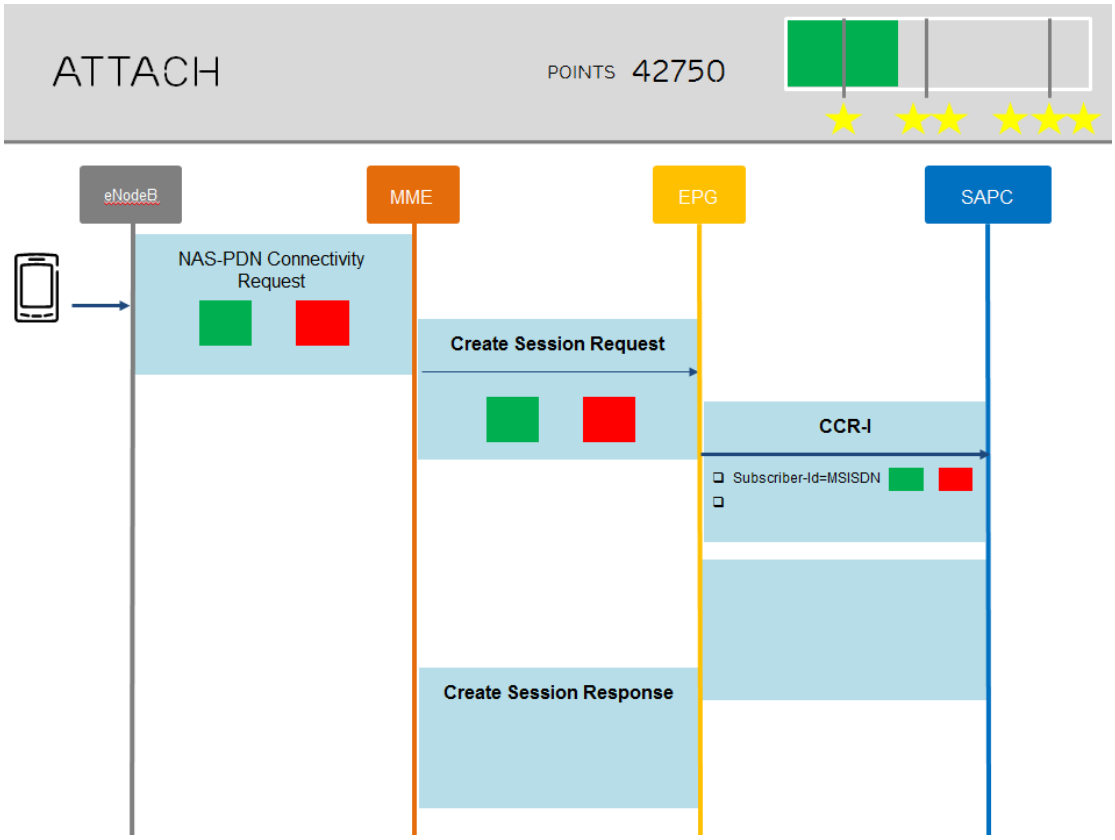

Figure 6.31: The third version of Call of VoLTE in which the learner can accept or discard signals that appear in the sequence diagram.

A major advantage with the game is its modularity. The game can incorporate any use case with a sequence diagram into the game. Since use cases are used extensively at Ericsson, the target group of the game becomes very large. The game is also flexible since it is very easy to add and remove information to adapt to different level of knowledge. The game can describe the overview of a use case by only showing the signals, but also in more detail by adding parameters. As such, the game can easily be adapted depending on how experienced the learner is and be played by both beginners and more advanced learners.

As for the other games, the name Call of VoLTE was temporary and was changed to Sequencer.

6.12 Hackathon

A Hackathon was organized by Ericsson employees where we and some employees from Packet Core participated. This event was not planned from the beginning but we were asked to join about one week before it started. It lasted for about 12 hours, but we participated for 8 hours. We thought it would be a good opportunity for us to show the game ideas to people outside of Packet Core and get their feedback. In total, we presented and talked about the ideas with 26 people, who had not seen the ideas previously. The game ideas received a lot of positive feedback and we gained valuable comments which were added to the list of future directions for the games, since we did not have time to change them all.

6.13 Developing a working prototype

As we saw a lot of potential with Sequencer, and it gained a lot of positive feedback from the employees, we choose to implement that game as a prototype. Compared to the other game ideas, we considered Sequencer to be the easiest to implement. The game would not require as much logic as EriSim and eWall and still include enough for a user test. However, when arriving to this point we revised the decision of creating a paper prototype. As Sequencer did not require as much logic, we saw the possibility of creating a digital prototype by using a prototyping tool. We looked at different alternatives, such as Microsoft Powerpoint, Axure and Storyline.

After discussions with Global Services we decided on using Storyline, which is a program that is used to create e-learning courses. There were several advantages to using it. The tool was flexible enough for rapid-prototyping and it was quite easy to change the prototype. As Kapp (2013*b*) mentions, Storyline has a low learning curve and since Global Services have previously used the tool, we could easily ask them for guidance and tips when necessary. Global Services has licenses which could be used to edit and develop the prototypes we have created. Powerpoint slides that we used to present the concepts were easily imported into the program and enabled us to have a quicker workflow. One of the disadvantages with Storyline was that some interactions were hard to simulate in the prototype due to limitations of the program. One such limitation was creating moving signals that could have drag and drop functionality. This was hard to simulate since Storyline had limitations in allowing parallel activities for the built-in drag and drop.

In figures fig. 6.32, the two prototypes are shown. The first version of Sequencer was user tested.

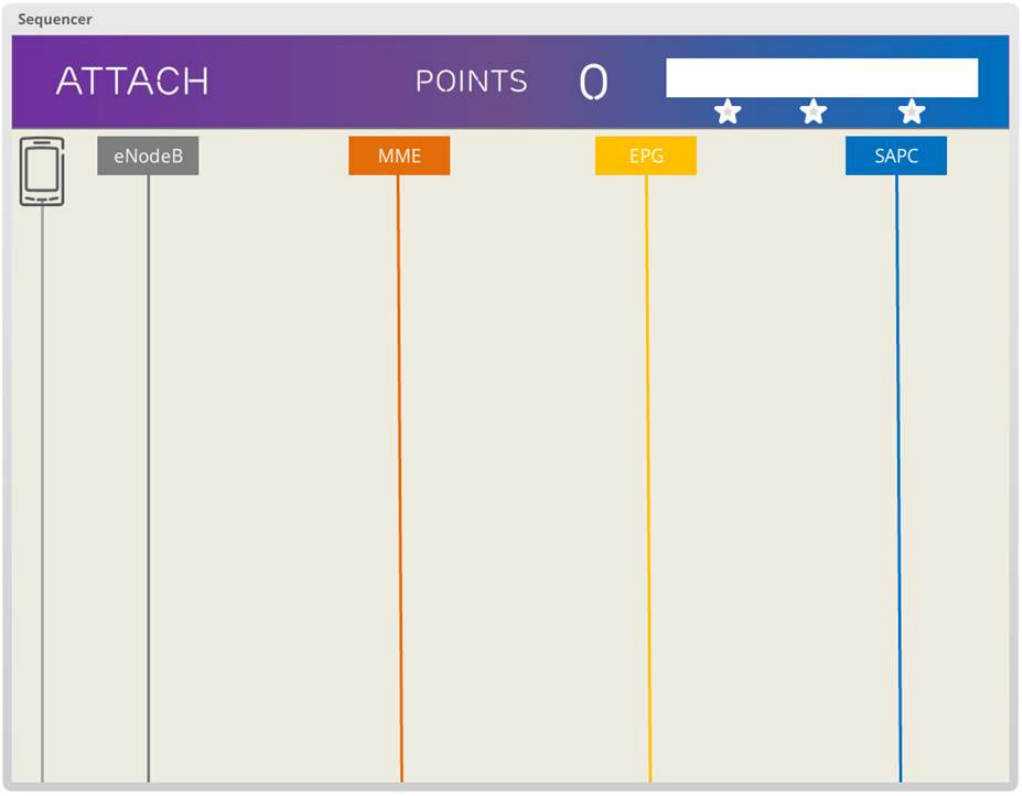

Figure 6.32: The prototype of Sequencer that was tested during the usability testing.

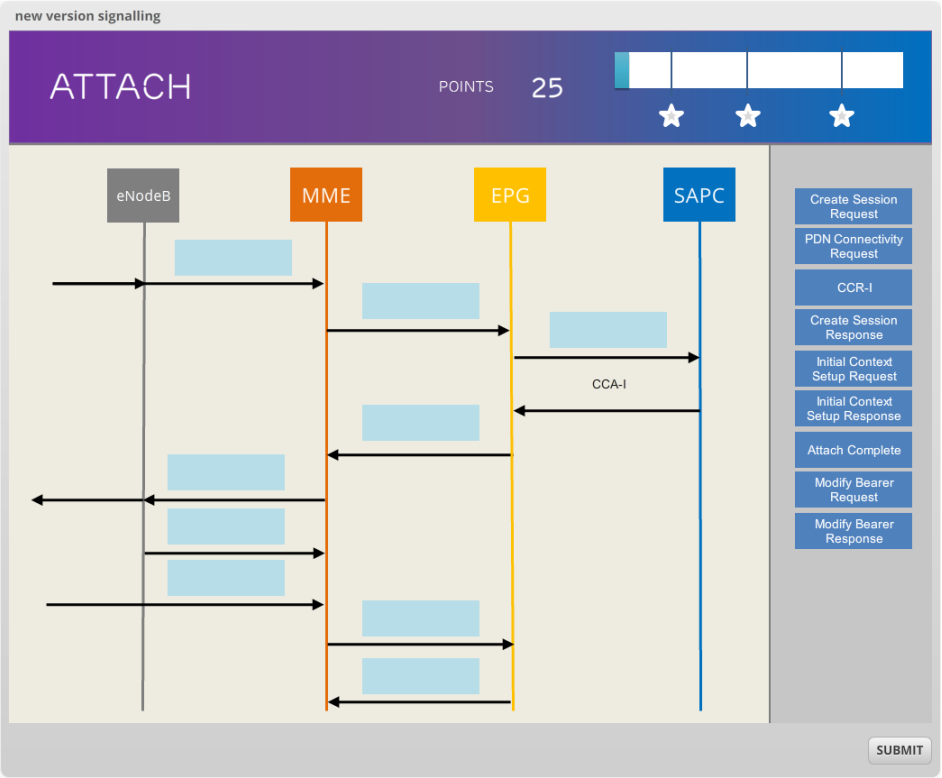

Figure 6.33: The second prototype of Sequencer which simulates the drag and drop concept of Sequencer. This prototype was not user tested due to the time limits of the project and also because it could not be fully implemented with Storyline.

6.14 User test of prototype

We decided to use formative user testing since this was the first prototype and it was also the first test of several tests to come. The usability testing method think aloud was used in a semi-structured interview setting during the test. The purpose was to gain knowledge of timing of questions, find how the prototype could be developed and what changes need to be made in order to test it during a training session. We selected five employees from Packet Core to test the prototype since that was a sufficient number of testers to identify the biggest usability problems, see section 4.6.1. It was also important that the employees were familiar with the use case and therefore the use case was attached to the invitation to the test session. Five sessions were carried out with five employees with different experiences and had different working knowledge of the use case.

A usability test template, including a user scenario, was created in order to use the same methods and question all of the test sessions. For the complete interview template, refer to Appendix E.

6.14.1 Result of user testing

Most of the testers were excited to test the prototype. However, all the testers found the game stressful. They wanted to have more time in order to think and reflect. Several testers tried to find connections between different questions in order to guess what parameters needed to be there for the next signal. Since the questions disappeared quickly and several questions appeared at the same time, testers did not always have enough time to read and make a decision to accept or discard an answer. The test was conducted on a laptop and the laptop screen was much smaller compared to screen resolution that was used when developing the game. The decreased resolution made the text much smaller during the test and made it even harder to read fast enough to answer the questions.

Another problem we observed was the unclarity of the instructions of gameplay. All of the testers wondered what was about to happen when they started the game. We had decided that the order of the signals would appear in should not matter in the game. This was to make the game more interesting but this was not mentioned in the instructions on how to play the game. The description of the game was short since people do not always read instructions.

Many testers also wanted to know the context for the sequence diagrams and which configurations were assumed before starting the game. One tester in particular got answers wrong because the parameters were not configured with the setup that person had in mind. The tester mentioned also that the same sequence diagram is used in other use cases. It was mentioned that it would have been helpful to use a scenario that describes what configurations and information are assumed before actually launching the game. Even though we were aware that we needed to specify information before launching the game we were not aware that the configurations were as important to know as it was.

The stars in the game were not intuitive as we had expected and we changed the number of stars from six to three. The correlation between the number of points and the number of stars was not clear. There can be two reasons for this: the first being that the lines that supposed to show the different point levels had little contrast. The second reason was that most of the testers did not have enough time to reflect over the number of points until the end of the game. To make the change of points and stars more distinct, "+10 points" could appear near the answer.

Another problem with game user interface was that the answers were supposed to melt into the background when the correct signal was in the right place. The background color was beige and the answer spot was white. The contrast between the two colors was poor.

We also found a few bugs in the game. One bug was the number of questions appearing was reduced during the end of the game since there were only a few questions left. To solve this bug one to add speed up the frequency of question during the end of the game. Another bug we found was that there the feedback on a few of the parameters was incorrect in the game.

6.14.2 Our observations and reflections

During the test several observations and fixes occurred to us. One such example was the frequency of questions. Timing should be adjusted so that the learners can read. Fewer objects should be shown at the same time so that the learner gets enough time to read. We had different amount of delay in the game and this was good to test the frequency of questions.

Another reflection was to accompany the game with different modes of play. Examples of game modes are practice, Tournament, different modes of stress level and a reading mode. A practice mode could have the same mechanics as the prototype but without the progress bar and points. It was evident that the testers read the signal and parameter names several times during the game in order to guess the next parameter or the next signal but they did not always have the time to do this. If they have had played the practice round first maybe it would have been easier to test the knowledge during the actual game generating game session.

One issue we had with the interaction was to make the distinction between accepting the right answer and discarding an incorrect answer. In both cases, the learner has done right but three out five testers found it confusing or did not see that the red button could give green feedback. One possible solution is to have one button instead of having two and letting the learner discard answers by just not accepting. Each signal and parameter could be buttons and if the learner clicks on a parameter a right answer will stick to the background and generate points and a wrong click will give minus points.

Another possible addition to the game would be to add a timer counting down to the start of the game. This would have helped the testers realize that the game depended on time. A time progress bar in the game could also show how much time is left since several testers asked how much time was left when the game got too stressful. The learner needs to be in control and a time bar would enable that. An addition of time progress feature would be to show how long time you have on each question so that the learner can decide which question to answer first.

There are several changes that need to be done to the next iteration of the prototype. Since we created the prototype during the last phase of the project we were not able to implement all the changes but all of the changes and possible solutions are documented for future development of the prototype.

6.15 Fourth iteration of guidelines

A final version of the guidelines was composed during the third iteration based on aspects that we realized when finalizing the game ideas and when performing the user test. Some insights we got during the development were brought to light when writing the final report and were also added to the guidelines. We chose to number of the guidelines to make it easier to refer to them by number.

The following guidelines were added: ‘1. Make sure a game is the way to go’, ‘2. Know the target group’, ‘4. Know the area of application’, ‘10. Decide game category’, ‘20. Consider design dilemmas’ and ‘35. Use a suitable look and feel’. The guideline ‘Put the learner in control’ included a description to both provide alternatives which the learner can choose from in the game and to let the learner have control over the learning. To distinguish these, the guideline was divided into 1’7. Give the learner interesting choices’ and ‘19. Let the learner choose where to enter the training’. Additionally, 13 of the guidelines were reformulated to have a more prescriptive title. See section 7.1 for the fourth complete guidelines document .

6.16 Presentation at Ericsson

We held a presentation at Ericsson during the next-to-last week of the project. Its purpose was to present the game ideas and our learnings from the research and from the project to employees outside Packet Core. We saw this as a good opportunity for us to spread the word of game-based learning at Ericsson to hopefully trigger more projects to be conducted in this field. In total, 26 people attended the presentation.

6.17 Summary of the design process

We began with a pre-study to learn more about Ericsson and to get an understanding of games and training. The pre-study gave us a knowledge base and created a starting point for us from which we could start with creating guidelines and developing game ideas. The guidelines are a summary of everything that we have learnt from the research, developing the games and from the feedback. Based on the pre-study and the guidelines, we developed game ideas that could be used in training at Packet Core. Ideas for games were elicited through brainstorming sessions and three of them were chosen to be future developed. We worked with the guidelines and game ideas in parallel throughout the project and carried out four iterations. For each iteration, the guidelines and the game ideas were improved and the guidelines’ development influenced the game ideas for the next iteration, and vice versa. See figure 6.34 for an illustrative description of the design process.

Feedback was received throughout the project from employees at Packet Core and at Global Services. The feedback was incorporated in each iteration and we changed the guidelines and game ideas accordingly. We organized one workshop where seven employees at Packet Core participated and took part in the development of the game ideas. Four follow-up feedback sessions, with groups of two or three, were held after the workshop to get additional feedback on the game ideas. User tests with five employees from Packet Core were carried out to test the prototype for one of the games. We participated at a Hackathon and presented the game ideas to 26 people and held a presentation for Ericsson employees where 26 people participated.

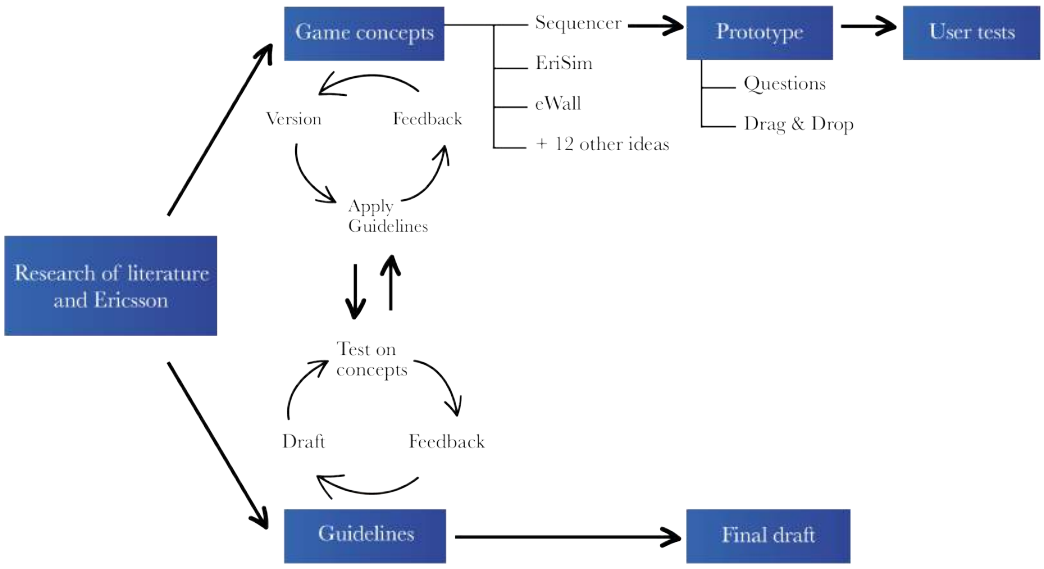

Figure 6.34: A summary of the design process including feedback iterations, guidelines, game concepts, a prototype and user tests.

7
Result

The study, including research, guidelines, game ideas and feedback, made up approximately 90 % of the time spent on the project. There are 37 guidelines and 15 games, from which three were chosen to be further developed. The development of a prototype and performing user tests were performed during the remaining 10 % of the project.

7.1 Guidelines

The guidelines are based on research, our experience when developing the games and feedback received throughout the project. In total, there are 37 guidelines that have been compiled through iterative work. The target group of the guidelines, as we see it, is educational game designers, instructional designers and interaction designers. Some guidelines are more general in their nature compared to others which are more specific to Ericsson. Table 7.1 below shows which guidelines each game is incorporating, followed by the fourth and final version of the guidelines accompanied with descriptions and examples.

Guideline	EriSim	eWall	Sequencer
1. Make sure a game is the way to go	1	1	1
2. Know the target group	1	1	1
3. Make a game complementary to internal training	1	1	1
4. Know the area of application	1	1	1
5. Gather domain knowledge	1	1	1
6. Decide the learning objectives	1	1	1
7. Organize learning objectives	1		
8. Connect learning objectives to a game design strategy	1		
9. Decide whether to test or teach	1	1	1
10. Decide game category	1	1	1
11. Pick a game genre	1	1	
12. Create a scenario	1	1	
13. Contextualize the learning experience	1	1	1
14. Let the learners know what they will learn			1
15. Throw the learner into immediate action	1	1	
16. Create an active learner experience	1	1	1
17. Give the learner interesting choices	1	1	1
18. Divide the content into levels	1		1
19. Let the learner choose where to enter the training	*		1
20. Consider design dilemmas			
21. Show game progress	1	1	1
22. Use learner-centered leaderboards	*	*	*
23. Reward effort	1	1	1
24. Keep the rules simple	1	*	1
25. Make winning the result of learning	1	1	1
26. Create multiple long- and short-term goals	1	1	1
27. Consider using time pressure		1	1
28. Include randomness when appropriate	*		
29. Try to avoid perfect communication	1		
30. Create a collaborative game			
31. Let learners fail but do not punish failure too much	1	1	1
32. Incorporate intrinsic motivators in the game	1		1
33. Create a story	1		
34. Bring the story to life with character(s)	1		
35. Use a suitable look and feel	1	1	1
36. Make it fun	1	1	1
37. Know the player types			
Number of used guidelines	**29**	**22**	**24**
Percentage of all guidelines	**78**	**60**	**65**

Table 7.1: An 'x' denotes that a game uses a guideline. A star (*) means that implementing the guidelines should be done in the future.

Pre-design

1. Make sure a game is the way to go

Development of games takes time. Consider if it is worth spending the time on developing a game, or if a more traditional teaching approach is better suited for the course content (Kapp 2013*b*). Using games can increase the level of attention since games are interactive require participation (Keller 1987).

2. Know the target group

By knowing the target group, a game concept can be designed to match the needs of the learner and relevance is important to motivate learning (Keller 1987). There are several different target groups, decide on which one the game should be designed for (Rogers et al. 2011). The groups can be divided into external (outside of Ericsson) and internal (within Ericsson). External target groups are:

- Potential recruits.
- Customers.
- School students.

Internal targets group are:

- New employees.
- Employees within the division.
- Employees outside the division.

3. Make a game complementary to internal training

Implement a game as one component within a larger training strategy. Use the game as a complement to other training. A game should not replace existing training and should be used as another medium of communication rather than a complete learning experience. Discussing before and after games can have positive effects on learning (Sitzmann 2011, Enders 2013). To gain attention of the learner it is good to vary the format of instruction (Keller 1987).

4. Know the area of application

Decide in which context the game should be used (Rogers et al. 2011). Possible areas of application are:

- Before a course for prerequisite knowledge.

- During a course to get more knowledge about the content.
- After a course to repeat the knowledge.
- When new employees are introduced to the company.
- For marketing purposes, explain for non-Ericsson employees what the company does.

5. Gather domain knowledge

Before initiating the design phase, you should have gathered all information which the course should include (Kapp 2013*b*). Make sure that you have understood the course content correctly by confirming with a course responsible. Throughout the design, ensure that the content is correctly described. Correctness of learning content in a game can gain the attention of learners to motivate to learn (Keller 1987).

6. Decide the learning objectives

Make a list of:

- Terminal learning objective(s) (TLO) - Overall goal with the course.
- Enabling learning objective(s) (ELO) - States the steps in accomplishing the TLO.

TLOs and ELOs are written from the perspective of what the learner will do, not what the instructor will do. They should be precise, unambiguous and state the requirement in clear, direct language (Kapp 2013*b*).

Example

TLO: After completing the game, a learner has acquired a basic knowledge of the nodes in both voice and data transfer networks and how they interact with each other to be able to continue the learning elsewhere.

ELO:

- Understand the similarities and differences between the 2G (GSM), 3G (WCDMA) and 4G (LTE) networks
- Identify and understand the nodes' functions in the Packet Core Network
- Identify and understand the relationships between the nodes
- Build a Packet Core Network of nodes and relationships
- Identify the difference between voice and data transfer networks

7. Organize learning objectives

Create a flowchart, tree diagram or another form of diagram using the objectives to see the connections between the objectives. Understanding the flow of the game can help apply game mechanics, planning levels at later stage of the design process. Use the chart to create other flows or storylines that run in parallel. The diagram can also help to see which objectives depend on each other (Kapp 2013*b*). The flow could also be organized to reflect the objectives' levels of difficulty to build confidence of the learner. Learners can build their confidence by being able to conquer the challenge (Keller 1987).

8. Connect learning objectives to a game design strategy

For each learning objective, decide the type of knowledge, type of learning (Bloom's Taxonomy) and appropriate game mechanics (Kapp 2013*b*).

Matching game strategy with knowledge type

A table showing the definition of different knowledge types, appropriate strategies when designing and examples of games (Kapp 2012).

Type of knowledge	Definition	Appropriate strategy	Tell-tale verbs	Examples
Declarative	Factual information that can only be learned through memorization	Mnemonics Elaboration Association	Identify Recognize Recall	Trivia Drag and Drop Memory Jeopardy
Conceptual	Grouping of ideas, objects having common attributes	Metaphors Examples Concept Map	Classify Discriminate Compare Matching and sorting	Wack a Mole
Procedural	Step-by-step instructions for performing a task	Start with the big picture Teach "how"s and "why"s	Verify Perform Follow	Pizza Hero
Problem Solving	Previously unencountered situation	Multiple examples Question Protocol Learning Documentary	Construct Create Design	America's Army

Figure 7.1: A table including types of knowledge and types of learning which can be matched up with different learning strategies.

Example

Here is an example of a table that for each ELO lists the type of knowledge, type of learning and game mechanics that can enable learning.

ELOs	Type of knowledge	Type of learning	Mechanics
Understand the similarities and differences between the 2G (GSM), 3G (WCDMA) and 4G (LTE) networks	Conceptual	Understanding	Missions, time perspective, resources
Identify and understand the nodes in the Packet Core Network	Declarative	Understanding	Action points, collecting

Figure 7.2: Match ELOs with type of knowledge, type of learning and game mechanics.

9. Decide whether to test or teach

Decide if the game should test or teach knowledge (Kapp 2013*b*).

A game to test

- Have a good understanding of the prerequisite knowledge.
- If the purpose is to evaluate skills, make a game that is closer to a simulation of the real world (Keller 1987).
- If the purpose is to test declarative knowledge, the game could be more abstract.

A game to teach

- Break down the learning objectives into components knowledge, skill and attitude (KSA) and match them with game mechanics (Kapp 2013*b*).

Knowledge, skill and attitude (KSA)

Knowledge - What terms and process should the learner learn?

Example: Differences between nodes, names of the nodes, what each node does, difference between voice and data networks.

Skill - Skills that need to be learned. Skills should be modeled in games to mimic real world behavior

Example: Let the learner build the network using nodes as building blocks to understand the logical representation of the network

Attitude - Is there an attitude that the learner should get after a finished game?

Example: Wanting to learn more about the nodes in the network

10. Decide game category

There are several categories when implementing games in training. Gamification, Serious games and Pervasive games are examples of categories of games. Kapp (2013*b*) matches types of learning with game categories.

Definition of game categories Gamification - "Using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (Kapp 2012). Serious games - "Games that do not have entertainment, enjoyment, or fun as their primary purpose" (Michael & Chen 2005). Pervasive games - "Pervasive gamers inhabit a game world that is present within the ordinary world, taking the magic circle wherever they go" (Montola et al. 2009).

Consider using:

- Gamification when the goal of the learning experience is to improve or enhance an existing learning situation.
- Serious games can be used for learning content that does not change often since they are not easily adapted.
- Pervasive games can be used when the game environment needs to be the real physical world.

11. Pick a game genre

A genre is a categorization of games used by the game industry and game journalism (Björk & Holopainen 2006, Kapp 2013*b*, Adams 2009). Some popular game genres are:

Platform games
Description: Games in which the learner controls an avatar and jumps between platforms and over obstacles to advance in the game.
Examples: Super Mario Bros., Dustforce, Equalize.

Puzzle games
Description: Games that features puzzle solving to test skills such as logic, pattern recognition and sequence solving.
Examples: Tetris, Portal, Candy Crush.

Real-time strategy games
Description: Games that involves resource gathering, base building and control of units. They are not turn-based and are typically viewed from above.
Examples: Civilization, StarCraft, Age of Empires.

Role-playing games
Description: Games in which learners take on the role of a character and perform actions within a narrative and a set of rules.
Examples: Pokemon Red/Blue, World of Warcraft, Diablo II.

Social/Casual Games
Description: Games with simple rules that do not require a long-term time commitment nor a special skill to play. They allow or require social interaction between the learners.
Examples: FarmVille, Quizkampen, Ruzzle.

Tower Defense
Description: A sub-genre to real-time strategy games where the goal is to stop the enemies from reaching a specific point on the map by building towers that shoot at them as they pass.
Examples: Kingdom Rush, Plants vs. Zombies, Defence Grid.

See more genres listed by (Wolf 2002).

12. Create a scenario

Create a set of images describing each step in a scenario of the game (Kapp 2013*b*). This can help in making ideas more concrete, finding potential problems and mediating the discussion around game mechanics. The images could include sketches of the game or interface and with short explanations.

Design for Learning

13. Contextualize the learning experience

Consider putting the learner in a context related to the course instead of focusing on one separate ELO or part of the content at a time, e.g. design the game or a level according to a use case keller1987development. A context can also help the learner understand the relevance and be motivated to see how the new knowledge from the game can be applied to existing knowledge (Keller 1987). Separating the context from the learning objectives can obstruct learning and understanding.

Example

Explaining each network node separately without showing how and why nodes are connected to each other can make it difficult for the learner to understand the node's role in the network.

14. Let the learners know what they will learn

The game should be designed to support specific and clear learning objectives (Kapp 2013*a*, Enders 2013). Clear learning objectives can increase the level of confidence to learn more (Keller 1987). When mixing the game mechanics with the content, you should always be able to answer how they enable learning (Hughes 2014*a*).

Use the following structure to inform the learner about the learning objectives (Hughes 2014*a*, Kapp 2013*a*, Enders 2013, Chatfield 2010):

1. Briefing - State the learning goals in the beginning of the game
2. Feedback - Provide rapid, frequent and clear feedback throughout the learning experience, do not wait until the end (Keller 1987). Use a point system to give instructive feedback and show the progression in relation to the learning goals.
3. Debrief - Highlight the learning outcomes when the game is over.

15. Throw the learner into immediate action

Even though the learner needs to know the learning content, the learner should not be bored from the start. In the beginning of the game, use action, or an activity, to draw in the learner and encourage further engagement (Kapp 2014*a*). The first few minutes determine whether learner wants to proceed in the game.

16. Create an active learner experience

The game should provide an interactive experience and focus on learner activities. Promote an active experience, not a passive experience (Kapp 2013*a*, Enders 2013). To gain attention of the learner, involve learners in the subject matter through active participation (Learning-Theories 2015).

17. Give the learner interesting choices

Give the learner interesting choices by providing alternatives which the learner can choose between to create and use different strategies (Fullerton et al. 2008, Björk 2015, Keller 1987).

18. Divide the content into levels

Let learners level up only when they have actively participated in the game, i.e. do not let the learner just click next or guess one alternative in order to proceed in the game. Instead, the learner should use acquired knowledge to be able to level up (Enders 2013, Keller 1987).

Levels can be used to chunk topics and lessons and each level should be tied to specific learning objectives. Use levels to show what learners need to do or learn in order to level up. Design levels to increase in difficulty during the gameplay (Enders 2013, Keller 1987). Levels can be designed in the following manner:

- First level or initial levels are the easiest and shows what the learners need to learn
- The second set of levels: let learners practice and apply the skills they have learned in the earlier levels
- The final level is the most difficult level and requires the knowledge from the earlier levels.

19. Let the learner choose where to enter the training

Give the learner control over the learning. Let the learner choose where to enter the learning by giving the choice of difficulty or learning content. A choice create a sense of engagement (Kapp 2014*a*). If the learner chooses the wrong level, it should be easily changed. By providing different options, the learners find content that is relevant to them and also and increases the level of attention of the learner (Keller 1987).

Game Design

20. Consider design dilemmas

There are several game design dilemmas that need to be considered when designing educational games. Some of them are:

- Punishment vs. no punishment
- Informative vs. mystery
- Include random events vs. direct feedback
- Start with learning objectives vs. throw the learner into immediate action
- Time vs. self-paced learning

21. Show game progress

Provide a way for learners to show off their progression to others, as a mean to drive competition (Enders 2013). Showing game progress can also increase the satisfaction of the learning experience (Keller 1987).

Examples of game mechanics that can be used to measure progress (Enders 2013, Kapp 2014*a*, Chatfield 2010):

- Points - use for status indicators and unlocking course content.
- Badges/Achievements - use to show non-linear progress.
- Game levels - use to show linear progress.
- Experience bars.
- Leaderboards.

22. Use learner-centered leaderboards

Create meaningful leaderboards that display the most important behaviors and activities for reaching the learning goal. Show where the learner stands in the rankings or where the learner's inner circle stands, do not just show the top performers. Keep the number of visible competitors low, focus on showing the people that are close to the learner in ranking (e.g. five above and five below) (Werbach 2015, Enders 2013, Hughes 2014*b*).

If the leaderboard does not refresh immediately, clearly communicate the updating frequency of the leaderboard to the learners. Consider resetting the leaderboard at the end of each week to give everyone a fresh start (Enders 2013).

Consider having multiple leaderboards to show progression:

- Overall
- On individual tasks
- In each region or office location

23. Reward effort

Reward the learner for completing challenges/objectives and achieving the designated learning goals. Use rewards to motivate performance, and not completion (Kapp 2014*a*). The reward must be meaningful to the learners and be somewhat difficult to obtain (Enders 2013, Chatfield 2010). Increase the scale of rewards as they move forward in the game. Create rewards of different values and sizes within the context of game (Howard-Jones & Demetriou 2009). Do not reveal all the rewards from the beginning, but instead show a subset of the rewards

(Bhasin 2014). Surprise rewards can create new dimension of motivation for the learners (Keller 1987).

24. Keep the rules simple

Design the onboarding of the game to a comfortable experience for the learners. They need to know the rules and gameplay before starting to play. Consider providing an optional tutorial or practice round that does not affect the scoring, leveling or winning. Keep rules, scoring and leveling simple (Kapp 2013*a*)

25. Make winning the result of learning

Winning the game should primarily be the result of knowledge acquisition or creation. Avoid making the learner lose early since that can cause a negative emotional experience (Kapp 2013*a*).

26. Create multiple long- and short-term goals

Create multiple long- and short-term goals that are based on the learning objectives (Chatfield 2010, Enders 2013). Keep the learner constantly engaged by breaking down a larger task into smaller sub-tasks which can be completed to earn points along the way. Also vary the length, difficulty and completion time of the challenges. Variety is important, but do not make the challenges too easy or too difficult (Chatfield 2010). Show a reminder of the current objectives during gameplay.

27. Consider using time pressure

Time can create a sense of urgency within the learners and make them prioritize tasks. Consider using time-based activities to mimic real-life time constraints (Enders 2013). Time pressure can have negative effects on the learning by inducing stress. The learner may not have enough time to read and react on the learning content.

28. Include randomness when appropriate

Provide an element of uncertainty, i.e. chance and random events (uncertain rewards etc.) (Chatfield 2010, Kapp 2013*a*). However, it might be inappropriate if the game should respond to the learner's conscious decisions rather than chance (Michael & Chen 2005, Keller 1987). Randomness can make the game more replayable but use random events with caution in educational games. Consider using random rewards for tasks that involve tasks that intrinsic motivation and use anticipated rewards for boring tasks (Keller 1987).

29. Try to avoid perfect communication

Communication, is often perfect (i.e., without delays and misunderstandings, etc.) in entertainment games, whereas some serious training applications should rather reflect that communication seldom is perfect (Michael & Chen 2005).

30. Create a collaborative game

If possible, create a game in which several learners must work in groups to solve a task (Kapp 2013*a*, Chatfield 2010). Groups facilitate learning better than individual game play. See examples of Social/Casual games under Pre-Design.

31. Let learners fail but do not punish failure too much

In games, people feel that they can fail and are intrigued by the risks (Kapp 2014*c*). Therefore a game should incorporate risk taking and promote freedom to fail by (Chatfield 2010, Kapp 2014*a*, Enders 2013, Fullerton et al. 2008):

- Providing the opportunity to try again until learner has achieved the goal and mastered the content
- Giving positive instructional feedback when the learner fails
- Awarding points for how well the learner is meeting the goals
- Not punishing failure too much (Keller 1987)
- Putting the learner at mock risk, e.g. Hangman

Motivation

32. Incorporate intrinsic motivators in the game

Design the game to engage people through intrinsic motivations. Avoid using only extrinsic motivations (Sitzmann 2011, Werbach 2015, Enders 2013, Kim 2011, Keller 1987).

Intrinsic motivation is acting upon pure personal interest or enjoyment whereas extrinsic motivation is doing something to gain rewards from external reward systems such as bonuses, badges, points. When a student is intrinsically motivated by his or her studies it means that the subject itself is interesting. An extrinsically motivated student could study just to get a certain grade or to gain status among other students. To use extrinsic motivators more successfully they need to attend basic human needs. Ryan & Deci (2000) divides personal needs

into three categories: competence, relatedness and autonomy. Extrinsic motivators can be perceived on a scale from external to internal whereas intrinsic motivation can only be perceived as internal drive (Ryan & Deci 2000, Learning-Theories 2015).

Examples of factors that contribute to intrinsic motivations are (Kapp 2014*a*):

- Challenge
- Curiosity
- Control
- Fantasy
- Cooperation
- Competition
- Recognition by others

Examples of factors that contribute to extrinsic motivations are (Kim 2011):

- Points
- Badges
- Levels
- Rewards
- punishments

Elements that contribute to flow (the state in which the learner's ability and game difficulty are balanced effectively) are (Kapp 2014*a*, Learning-Theories 2015):

- Achievable tasks
- Control over actions
- Clear goals

Game Aesthetics

What kind of emotion or feeling do you want to convey with the game? The look and feel of the game is important to create an engaging game experience.

33. Create a story

Set the scene and create a compelling plot. Present a conflict the learner tries to solve with the game. Conflicts can grab the attention of the learner (Keller 1987). Learning objectives should

be embedded in the conflict (Enders 2013). Content-related stories can motivate learners to learn (Keller 1987).

Create a story that increases mystery and curiosity by only revealing parts of information (Kapp 2014*a*). For example, if it is a treasure hunt game, hints and mystery can reveal information about the location of treasure rather than revealing the location from the beginning of the game. Reveal parts of the map throughout the game. The gap between unknown and known information creates a mystery that the learners immerse in.

Characteristics that enhance mystery (Kapp 2014*a*):

- Novelty
- Complexity
- Inconsistency
- Surprise
- Incomplete information
- Inability to predict the future

34. Bring the story to life with character(s)

Consider using several characters that learner can relate to, each providing a different type of knowledge or support. For example, one character can be the instructor and another character can be a mentor for the learner. Let the characters involve the learners emotionally. Make sure that the character use an appropriate tone of voice that suits the learning experience (Enders 2013). Do not focus the gameplay around leveling up a character since leveling up should correlate to how the learner has learnt and not the character (Björk 2015).

35. Use a suitable look and feel

For corporate environments such as Ericsson the game's look and feel can look childish or not serious enough for use at work (Norman 2004). Test different look and feels on the target group in order to find the right match. A childish looking game can look more like a game but also be more abstract whereas a game looking like the workplace may not look like a game and or be on verge of being boring. However, humor and humorous analogies can motivate the learner

36. Make it fun

Examples of game mechanics that can add fun to the game (Fullerton et al. 2008, Kim 2014):

- Collection

- Surprise
- Rewards and punishment
- Progress
- Anticipation
- Story
- Construction/destruction
- Self-expression
- Social interaction
- Challenge
- Making interesting choices
- Competition

37. Know the player types

There are four player types: explorers, creators, competitors and collaborators. Consider targeting the core motivations for each player type when designing (Kim 2014).

Explorers

- Motivated by discovering the ins-and-outs of the game world as well as accumulating and showing off knowledge.
- Love to challenge the game world.
- Value accurate info, clever design, and relationship-building via knowledge exchange.

Consider the following to gain explorers' attention:

- Create an environment that can be explored with loopholes with a clear system of rules.
- Allow for single player mode.

Creators

- Motivated by opportunities for self-expression.
- Love tools and systems that let them personalize their experience and express their uniqueness.
- Value originality, creativity, hard work, and personal style.

Consider the following to gain creators' attention:

- Let them customize backgrounds, fonts and avatars.

Competitors

- Motivated by testing their skills and seeing how they stack up.
- Love to develop their skills and know where they stand within a group.
- Value mastery, learning, and relationship-building via friendly competition.

Consider the following to gain competitors' attention:

- Create external ranking systems.

Collaborators

- Motivated by working with others towards a greater goal
- Love to "win together" and measure success as collective impact.
- Value teamwork, shared learning, and relationship-building via shared tasks.

Consider the following to gain collaborators' attention:

- Create a co-op game or add game elements that encourages forming partnerships or teams.

7.2 Game concepts

Three game concepts have been developed based on the research and the guidelines. The game concepts are designed to be used for internal training at Packet Core. They can also aid in future development by providing a reference point and acting as mediating tools during discussions about game design.

Below follows a description and a scenario for each of the games. The description of the games follows the template provided by Kapp (2012).

EriSim

Overview of concept

The concept is a web-based single-player strategy game in which the learner comes to a city which has working 2G voice network and is in need of a data network. The goal is to build

a data network for 2G, 3G and 4G. The learner places nodes on the map and connect them to build a working network. New employees at Packet Core can gain a basic knowledge of 2G, 3G and 4G networks. The game includes which nodes Packet Core works with, how they are connected and their function in the different networks.

Outcome

New employees to Packet Core will learn the functions of each node and the connections between them.

Learning objectives

Terminal learning objectives

- Learn the overview of Ericsson Packet Core.

Enabling learning objectives

- Understand the similarities and differences between the 2G (GSM), 3G (WCDMA) and 4G (LTE) networks
- Identify the difference between voice and data transfer networks
- Identify and understand the nodes' functions in the Packet Core Network
- Identify and understand the relationships between the nodes

Description of characters

There are two characters in the game, the city's mayor and a mentor. The mayor has needs, e.g. "My town needs Internet" and the mentor turn those needs into objectives, e.g. "Build a 2G data network".

Environment

The games takes place in a city viewed from above and houses, streets and the population are visible. A 2G voice network already exists in the city and the nodes and masts which makes up the network is shown on the map.

Description of gameplay

The learner's goal is to build a data network for 2G, 3G and 4G.

The learner places masts and nodes on the map and connects them by clicking to create a working network. There is information that can be read by the learner about each node. Making incorrect connections will reduce the satisfaction bar since people would have no access to working Internet. The learner needs to read in order to get the connection right and the knowledge is assessed by placing the nodes and connecting them correctly.

A node is grey when it is inactive. When connected properly, the node gets a blue outline. Signals will flow in a subtle manner between two connected active nodes. The signals could have different patterns to illustrate digital and analog signals.

Levels

Available levels are 2G voice, 2G data, 3G voice, 3G data and 4G.

Movement in the background

The population will begin by standing still in the city. To illustrate the function of the MME/SGSN, the population will start moving when it is built. When people gather around a single mast, it could go down due to overload. When the network is down people will become be unhappy and the learnerer needs to quickly repair or replace the mast to increase the satisfaction again.

Time limits

Time is omitted to enable learners to learn at their own pace. However, if the satisfaction has been low for too long the learner loses.

Money

The nodes cost virtual coins to build. Money is earned when there is a working network in the city.

Satisfaction index

Measures how satisfied the city's population is. The satisfaction bar changes dependent on the player's performance. The learner needs to achieve the minimum level in order to advance to the next level. To keep people happy, the learner should provide network coverage to the population at all times. The satisfaction depends on the placement of a node in a good geographical area, creating full network coverage with minimum amount of masts and nodes etc. If the satisfaction is low for too long, the learner loses.

Badges

Badges are earned when completing objectives, they can be gold, silver or bronze depending on the learner's performance. The badges are presented on a status report which will be shown when the level has been completed, or when the satisfaction has been low for too long. The report also shows a summary of the network that was built.

Look and feel

A picture from the game concept Technology For Good developed by Global Services has been used as a background in the game and could be changed.

Technical description

The game is not yet implemented. However, a good starting point could be to prototype the game and playtest it. This could be done with Storyline which is used by Global Services. The end product should be web-based for easy accessibility through several devices.

Motivations

The game teaches a lot of acronyms that are used daily at Ericsson, i.e. declarative knowledge. According to research, declarative knowledge, such as acronyms and jargon, is key to understand to be successful, especially for new employees. By creating a game that helps the learner acquire this knowledge provides a strong base for future learning. Basing the game around a story was done because information presented through a story can be easier remember and gives a context for the learning. There are several levels in the game and after each level, the learner is also awarded a badge of different values depending on the performance as an enticement to replay and perform better. By playing a level several times, learner will hopefully understand some new knowledge and repeat it to remember it better. The game is designed to assess that the learner has understood the knowledge by confirming the placement of nodes. This will also make the learner act on the knowledge gained by playing the game which is desirable. The satisfaction is implemented to motivate the learner to perform well.

The purpose of the game is to visualize what Ericsson does and connect Ericsson with the end user. The game uses the logical overview of the network to simplify the reality but since many employees refer to this logical map of the network new employees should also be aware of it.

Potential target groups

- People outside of Ericsson without technical knowledge
- People with technical knowledge that do not work at Ericsson, e.g. students.

- Early school stages to create an understanding for what Ericsson does and also create an interest for technology at early ages.

The game could be used by different target groups both internally and externally at Ericsson. For employees, the game needs to contain more details of the network. For new employees or people who wants to know more about Ericsson, the game could be used to give a basic knowledge about the networks. The game can possibly be played near the demo wall at Ericsson Lindholmen to explain the functions of the nodes that are placed at the wall.

People should move in the background and there should be reasons why they move and act as they do. Just adding people in the background without no reason is not a good idea since it just disturbs the flow without adding any extra value. Using characters in the city the learner could relate to their own lives and needs and see how Ericsson works with the infrastructure. Movement and facial expressions could create more immersive experience.

The money in the game is represented by virtual coins so the learner does not confuse the costs of nodes and masts in the game to what they cost in reality.

To make the appearances of the character consistent throughout the game, the mentor appears from the left hand side and the mayor appears from the right hand side. The characters should talk and answer as they would do in real-life. When the network has been inactive the mayor could come out and say "Ah, this wasn't what I had hoped for" and the mentor could hint on how to proceed.

Future Directions

- The game could start in a small city and then as the player continues in the game the geographical area increases to a country or a continent. If a bigger geographical area is used however, the connections between the population and the learner is lost since the scale would not allow them to be shown. The advantage with large scale maps is the realism and there is more space to place several masts, nodes and be more realistic to how nodes and masts work today.
- Factors that can provide more choices of strategy to the learner are capacity, population size as well as geographical area and conditions such as buildings, mountains and humidity.
- To make the connection between the satisfaction bar and the badge clearer and also to create an emotional response, smilies can be used as badges. The smilies could be sad, ok, happy or very happy. This needs to be tested in order to see if the response of the target group is as expected. Learners need to finish the game with an ok-simley in order to level up. A possible reaction for a learner would be to say "Ah, I only got an ok face. I need to find a way to get a happy face".
- Different look and feels need to be considered to find one that works well. The look and feel can be something similar to the images found at http://mediabank.ericsson.net/

search/interactive%20media/ (if the link doesn't work go to Ericsson's media bank and search for interactive media).

- The game should not feel too stressful since the purpose is to learn and the learner should get plenty of time to read and make decisions. However, the learner should also be active during the process so other motivators than time should be examined.
- If the game is more story-based one could use cutscenes after each level to show how the city evolves as the network is upgraded. For example, the city could be inhabited by a few people in the beginning and as the network improves, more people will come to the city and more buildings could appear during the cutscene.
- The game could start with a planning phase where the player has to fulfill the needs. This could take place in a planning room and when the user has planned, he or she could submit the plan and then a scenario can be played to show the result of the plan. The consequences of the plan could be shown in scenarios. For example, if the capacity of the nodes are bad then the the network may work in the beginning but it will then go down due overload.
- It could be possible for the learner to choose which level to play. If the learner already has knowledge about 2G, the game could start with building the 3G network.
- Future use cases or scenarios that could be used to get a deeper understanding of the nodes' functions are:
  - Internet of Things and Connected Cars
  - SRVCC, CS fallback, full LTE coverage
  - Microwave, placement of masts (Different coverage, capacity, small or large antenna, unintrusive looking antennas etc.)
  - Features QoS, UE tracking
  - Emergency calls, masts are overloaded etc.
- The game can include a leaderboard so the learners can compare their performance with others.
- Different look and feels need to be tested on the target group in order to decide which works well. Possible appearances are modern, cartoon or using photos to make make the scenarios more realistic.
- There could be different types of people who can have different kinds of needs (Wi-Fi, music, stream). For example, teenagers, business people and families.

Scenario of EriSim

Figure 7.3: The start of EriSim

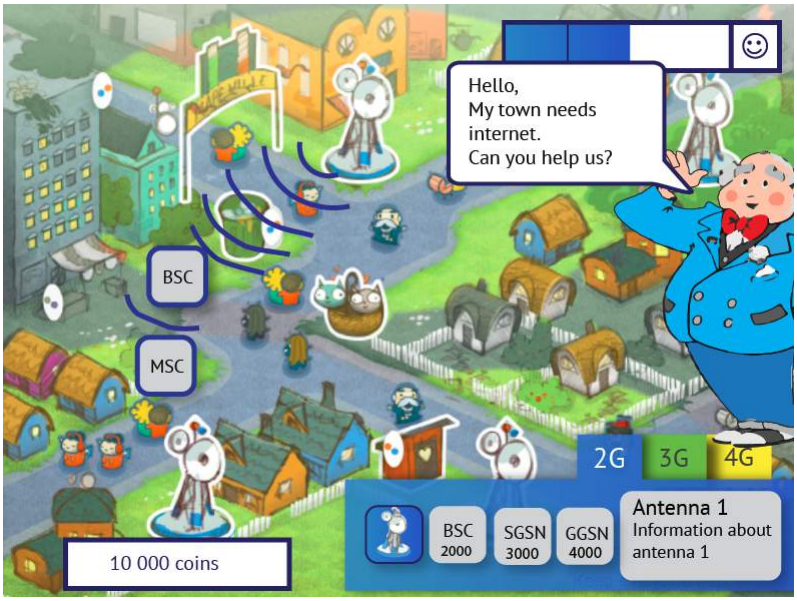

Figure 7.4: Mayor asks for 2G data network.

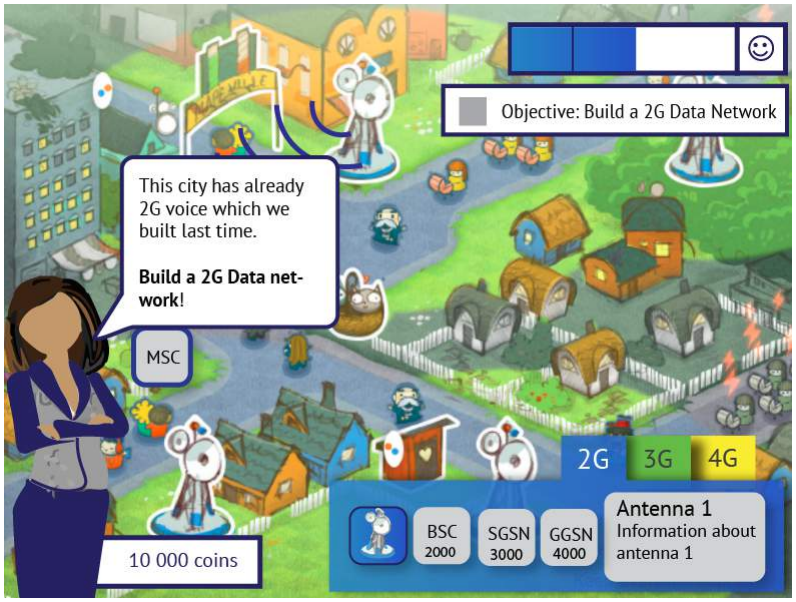

Figure 7.5: The mentor help set the network

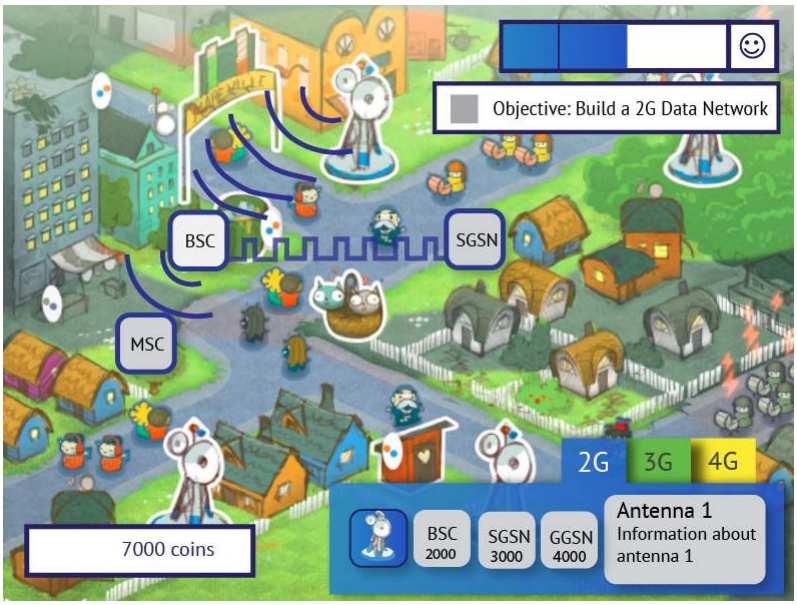

Figure 7.6: Placing a SGSN node.

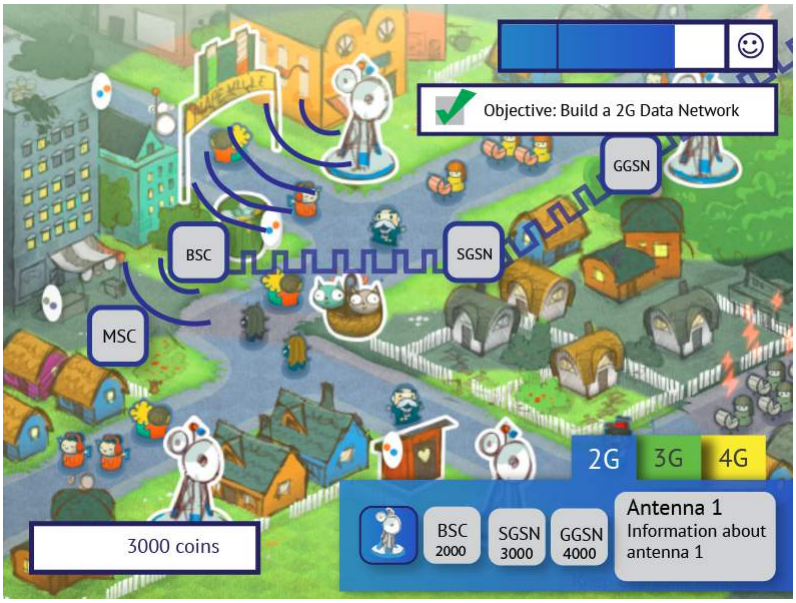

Figure 7.7: The completed 2G network.

Figure 7.8: The learner earns a diploma and receives a summary.

Figure 7.9: The mentor explains the badge.

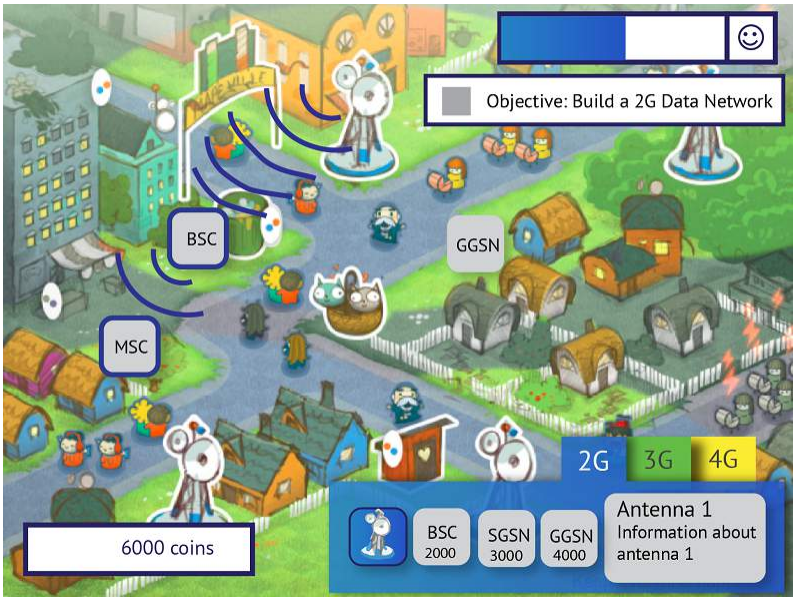

Figure 7.10: A learner placing the wrong node.

eWall

Overview of concept

The concept is a platform game in which the learner controls a packet through the network, from the user equipment to the Internet, according to a pre-defined use case. The learner collects parameters and drops them off in the right node. Enemies are spread out across the map and can hurt the character. The map is a representation of 'Väggen' (the demo wall at Ericsson Lindholmen) to make a connection between the game and the physical demo wall. The target group is new employees at Ericsson who wants to know more about the network overview.

Context of use

The game could be played near the demo wall to give the learner an explanation of the network both through the game and through the wall.

Outcome

The learner should get an understanding of each node's functionality in the network and what parameters are sent between them.

Learning objectives

Terminal learning objective

- Get an understanding of the overview for the 4G network including the nodes' functions and parameters passed between the nodes.

Enabling learning objective

- Identify which nodes are involved in the 4G network.
- Understand how the nodes are connected.
- Identify the parameters that are passed from one node to another.

Description of characters

A packet with arms and legs. The packet has a backpack where the collected parameters are stored.

Hackers (or packet sniffers) has vacuum cleaner which can damage the packet. They are spread across the map and walk back and forth in a designated area.

Environment

The game takes place within the nodes, cables and microwave signals of the network. The map is a representation of demo wall and the platforms are located within the nodes.

Description of gameplay

The learner controls the packet and jumps between platforms to reach parameters on its way to Internet. Parameters are located at different locations in a node, which the learner has to pick up. Information about the parameters is displayed when the parameter is picked up. The parameters should be carried and dropped off at a certain location in another node. If a parameter should be dropped at several nodes, the learner receives multiple copies of the parameter when picked up. The learner can open the backpack and see the content to get information about each parameter. Text describing the nodes' functions are displayed on the background which the learner can read while passing.

The top of the screen shows the name of the node which the packet is currently in, the number of picked up parameters and the number of delivered parameters for the current node. The learner has three lives, which are also displayed at the top of the screen. Lives are lost when an enemy deals damage or if the packet falls into a gap. If all lives are lost, the learner loses. An enemy is killed by jumping on the enemy.

The package has a 'Time to live' (TTL) value, which decreases during the game. Checkpoints exist at appropriate locations on the map. When the learner reaches a checkpoint, the TTL increases and the learner's progress is saved. If the TTL runs out, the player loses. The game is paused when opening the backpack to read about the parameters. Reading should not affect the TTL.

Look and feel

The game is based on a photography of the demo wall and drawn characters are added to the map.

Technical description

The game is not yet implemented. However, a good starting point could be to prototype the game and playtest it. This could be done with Storyline which is used by Global Services. The end product should be web-based for easy accessibility through several devices.

Motivations

This game follows a use case and provides an end-to-end perspective of the network, which gives the learner a context. The map is represented by the to get a connection between the game and real life. The game acts as a complement to the demo wall by going into more detail of the network. Thus, the game can be played at the demo wall to clearly see the connection between the game and the physical wall.

By showing the number of picked up parameters and the number of delivered parameters the learner gets instant feedback on the progression. The learner can see how much is left to be completed within each node and can divide the main goal of completing the entire map into several sub goals.

The game is paused when reading the information for a parameter to encourage the learner to read and understand the knowledge and not just guess through the game.

Future directions

- Gaps between platforms on the map can be represented by broken cables, i.e. the packet could fall out where a cable is broken or jumps between antennas or nodes.
- When dropping a parameter in a node, consider showing the response signal that is sent back to the previous node.
- Choose different types of packets (surf, music, video). The map could change depending on the type of packet the learner chooses.
- The learner could collect ones (1) and zeroes (0) to score points.
- The enemies can hold parameters which they drop when they are killed.
- Consider including security aspects when killing an enemy. The learner might need to apply different methods to counter a threat to the network.
- Illustrate the nodes' functions while playing. For example, when exiting the EPG, the packet can get an IP address. This is one of the functions of the EPG.
- Consider dropping a parameter by the entrance to the node, and not at different locations within a node.
- The backpack could increase in weight when picking up parameters which affects the packets mobility.
- Wind and rain could affect the jump made through the microwave signals between the minilinks.
- Consider adding the ability for the learner to clone the packet to illustrate redundancy within a network.

- Create a tutorial or a practice round without points to clarify the rules.
- Add a choice of use cases before the game to put the learner in control of what to learn
- It is important that completion of the game mirrors the level of the knowledge. A learner should not be able to just guess through the game. Therefore, several parameters will be located in the game but only a few of them should be picked up and the learner needs to know which ones to pick up.

Scenario of eWall

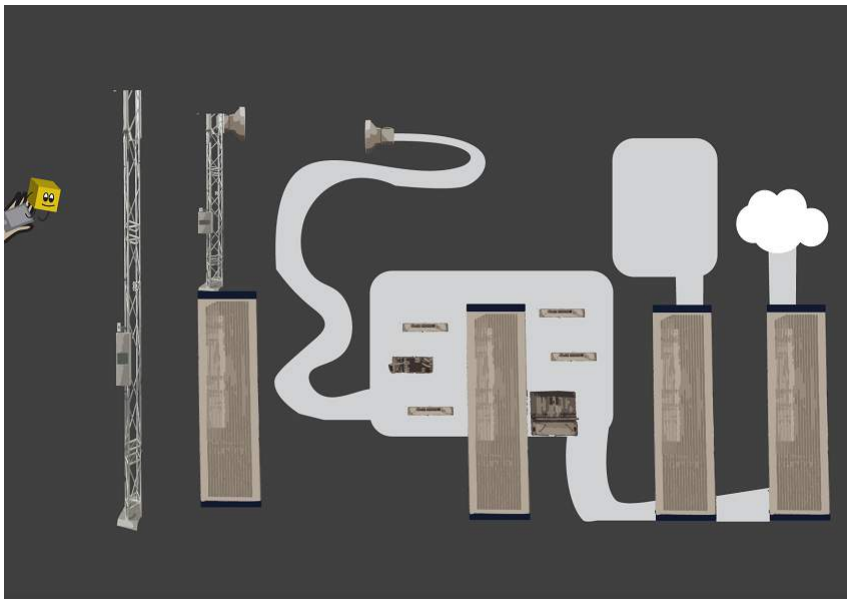

Figure 7.11: The whole eWall game

Figure 7.12: The packet travels down the antenna to the eNodeB.

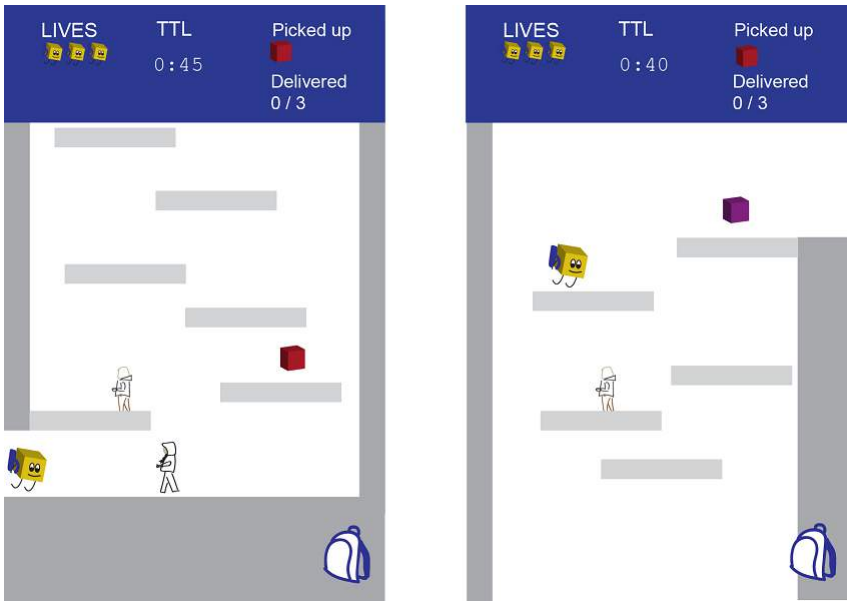

Figure 7.13: The packet continues through the nodes and encounters hackers.

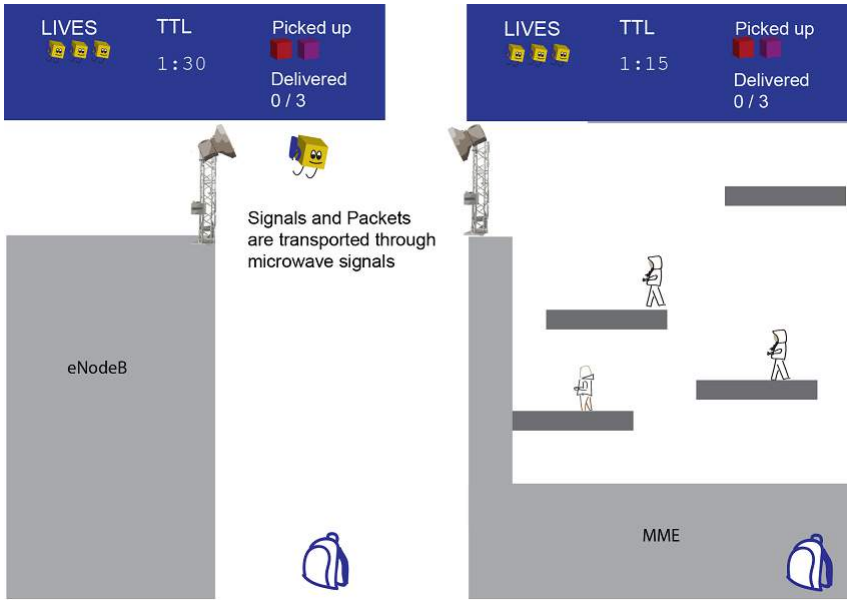

Figure 7.14: The packet is transmitted through microwaves to the next node.

Figure 7.15: The backpack storing the parameters.

Sequencer

Overview of concept

The game is for employees to test knowledge about the location of signals and parameters of a use case in a sequence diagram. Initially, the screen shows a sequence diagram without any signals between the vertical lines. As the game progresses, the learner should place the correct signal and parameter at each position in the diagram until there is now more space. The learner can select different use cases to play, which will change what signals are shown. Any use case can be implemented to be included in the game.

Context of use

The game can be played as part of an internal training course. It can be used

- before the session

- after the session (knowledge assessment)
- during the session

Outcome

Employees will learn a use case and its signals and parameters.

Learning objectives

Terminal learning objective

- Test knowledge about a use case and the location of signals and parameters in its sequence diagram.

Enabling learning objective

- Identify the prerequisites of a use case.
- Identify which nodes are involved in the use case, i.e. where in the telecommunication network the use case is performed.
- Identify the source that initializes the use case.
- Remember and understand the signals and parameters which are part of the use case.
- Identify the result after the use case is performed.

Description of gameplay

The basic scenario of the game is the following:

1. Choose a use case.
2. Get information about the use case and gameplay.
3. Choose difficulty level (with different level of detail).
4. Play.

The information about the use case should contain (at least):

- The prerequisites, what is needed to be established and performed before the use case starts.
- Settings and configurations for the use case.
- Show using text and an image which nodes are involved and where in the telecommunication network the use case is performed.

- The source that initializes the use case.
- The result after the use case, what is established after the use case.

The information about the gameplay should contain (at least):

- The learner's goal in the game.
- The fact that the signals do not need to be placed in the correct order
- An example of how the placement of signals works.

There two alternatives to the game.

Accept or discard

Empty boxes are positioned in the sequence diagram where signals should exist. Signals appear in the boxes and the learner can either accept or discard them. The questions appear randomly across the screen and the learner has to answer them under time pressure. The first question is whether the name and direction are placed correctly. The remaining questions are whether a parameter is part of the signal or not.

If the learner answers correctly

- The signal remains at the location.
- There is a delay until the next question appears at the same location.
- Points are increased.

If the learner answers incorrectly

- The signal disappears from the location.
- There is a delay until the next question appears at the same location.
- Points are decreased.

Drag and drop

Empty boxes are positioned in the sequence diagram where signals should exist. Signals fall from top to bottom at the right hand side of the screen. The learner should drag and drop a falling signal and place it at the correct location before it reaches the bottom.

If the learner places a signal correctly

- The signal remains at the location
- Points are increased

If the learner places a signal incorrectly

- The signal disappears from the location
- Points are decreased

If a signal reaches the bottom the learner lose points.

Points and stars

Points are rewarded when placing the right signal at the correct location. The learner loses points if a signal is placed incorrectly or if a question is not answered. Points are transformed into 1, 2 or 3 stars. Points and stars are shown in the top bar.

Look and feel

The game shows a sequence diagram in a clean and simple way.

Technical description

The game has been developed into a prototype in Storyline, used by Global Services. A good starting point is to test the game further. The end product should be web-based for easy accessibility through several devices.

Motivation

A major advantage with the game is its modularity. The game can incorporate any use case with a sequence diagram into the game. Since use cases and sequence diagrams are used extensively at Ericsson, the target group of the game becomes very large. The game is also flexible since it is very easy to add and remove information to adapt to different level of knowledge. The game can describe the overview of a use case by only showing the signals, but also in more detail by adding parameters. As such, the game can easily be adapted depending on how experienced the learner is and be played by both beginners and more advanced learners.

The game's focus is on testing knowledge, not so much on teaching. However, the learner can still learn new knowledge by playing the game. The learner can be motivated intrinsically by confirming oneself that he/she knows the information. The game can also make testing, which is a part of training, more motivating and interesting.

The game contextualizes the learning experience by providing a use case to the learner. A use case is a familiar way of describing functionality.

Future directions

- Include a leaderboard to trigger competition between departments or individuals. It should be meaningful to score high points.
- Possibly provide various modes of play, such as practice, competition (score is gained and leaderboard could be active) and reader friendly. Each mode can be different difficulty level, i.e. how fast the questions appear and how many parameters are shown.
- Receive minus points when a question is not answered.
- Show a counter in the beginning to indicate when the game starts.
- Make it clear in the beginning that the game can be played several times. It is not a test which can only be played once.
- Include troubleshooting.
  - Possibly keep a signal or parameter which is placed at an incorrect location. Then the use case will not work and will require the learner to look through the signals (without time constraints) and find the problem.
  - Look at realistic logs (from Wireshark) to find problems.
- If a node stops working, what happens then? The learner might need to do some changes to solve the problem.
- Read print-outs after the game has finished. Compare the result to the use case to get a deeper understanding of what is happening.
- The learner can possibly build the network of nodes before playing to get another level of knowledge. The game can perhaps be merged with EriSim.
- What happens to the signals when they reach the bottom in the Drag and drop alternative? Perhaps they fill up a pond of water which at some point floods out and covers part of the diagram, making it impossible for the learner to continue. Can perhaps represent congestion in the network.
- Consider directing to CPI to get more information about the signals and parameters.
- When signals are accepted a notification can appear with similar text as “Good job! You finished the use case”
- Show a connection to IMS created when in the end of the game
- Create a time bar so that the learner knows how much is left.
- Replace the two buttons with only one accept button. The learner has to press the button to accept a signal. If the signal is incorrect, the learner can just let it disappear (the points are unchanged). If a correct signal disappears (the learner does not press the button), the

learner loses points. There might not be a need of an actual button in this case, it can instead be possible to click on the signal or parameter to accept.

Possible ways of making the game more difficult

- Bombs that remove accepted signals.
- Increase the frequency of showing questions.
- Increase the number of parameters.
- Empty positions in the sequence diagram where no signal should be placed.

Signal and parameters

- Go into detail of one signal and play a sequence diagram for that.
- Click on a signal to get more information about it (perhaps from CPI).
- Find an appropriate frequency at which questions appear.
- Make it clearer when a signal/parameter is completed, for example by changing text or background color.
- Make it clearer if the question concerns the signal or the parameter.
- When a signal has been discarded, remove it from the loop of recurring questions.
- When there are only a few questions left in the end, increase the frequency of questions so that the learner does not have to wait.
- Show the time until a signal disappears. For example, indicate by a fading animation or by changing the background color.
- Display the question longer when it concerns the parameter. During the user tests, people reread the signal name and previous parameters to figure out if the current parameters should be included. Thus, provide more time so they can be read again.
- Include text or an icon on the button, and not only a color, to indicate its function, i.e. a checkbox and a cross.
- Make a distinction between the green feedback received when pressing the green button and the red button. Avoid "I got green feedback but the signal did not remain at the location" which was expressed during the user test.

Points and stars

- The correlation between points and stars was unclear. Perhaps indicate on the progress bar how many points is required to receive another star.

- The grouping of stars was unclear.
- How many stars the learner received was unclear. People thought they received six stars. Change to showing only three stars, one at each level which the learner gains when reaching enough points.
- Make a clearer indication of when the score changes. Either through an indication by the progress bar or showing how many points are scored or lost when answering a question, e.g. show the text '+10' above the signal when it is answered.
- Possible ways of earning more points are through bonuses and/or combos.

Scenario of Sequencer

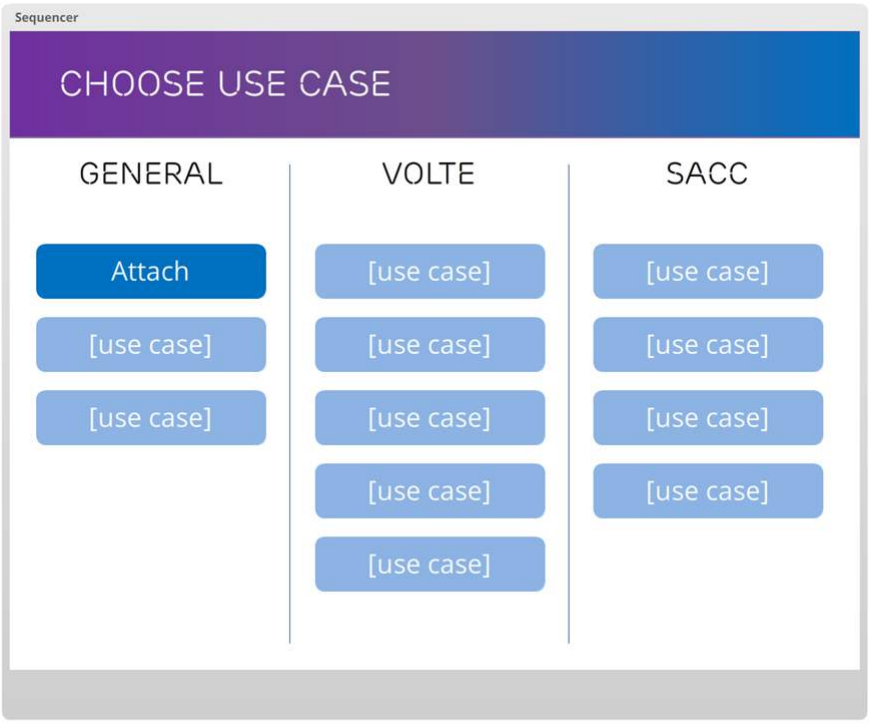

Figure 7.16: The learner can choose which use case to play.

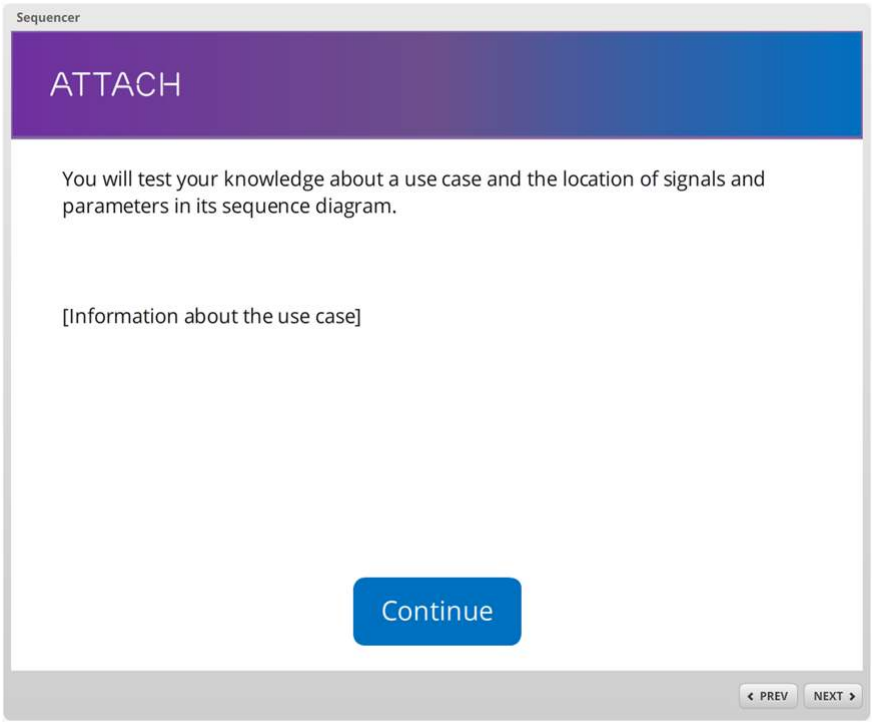

Figure 7.17: Information about the use case and what knowledge the learner will test.

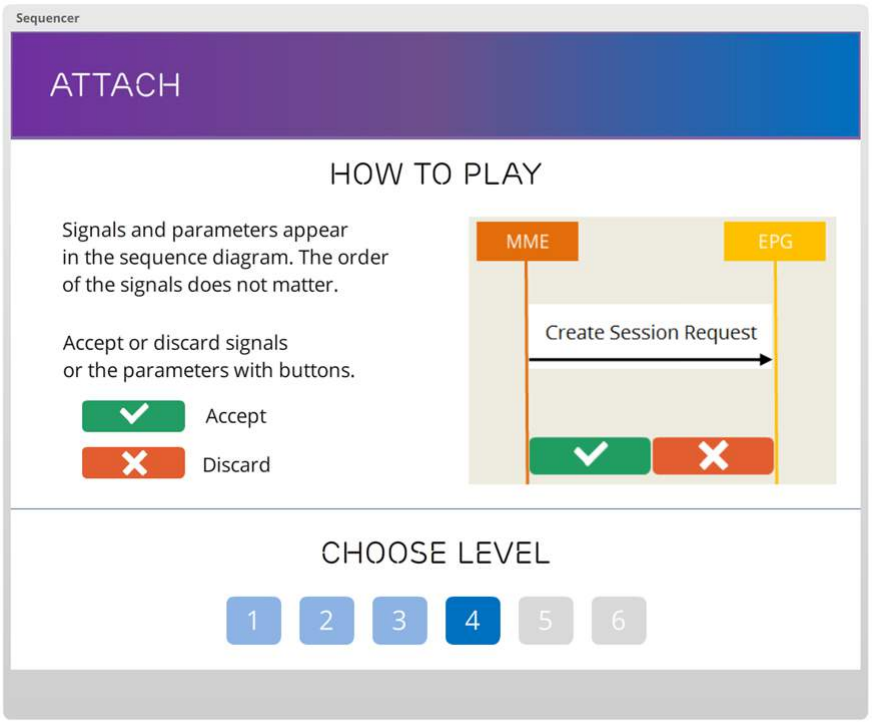

Figure 7.18: Information about the gameplay is displayed. The learner can also choose the difficulty level.

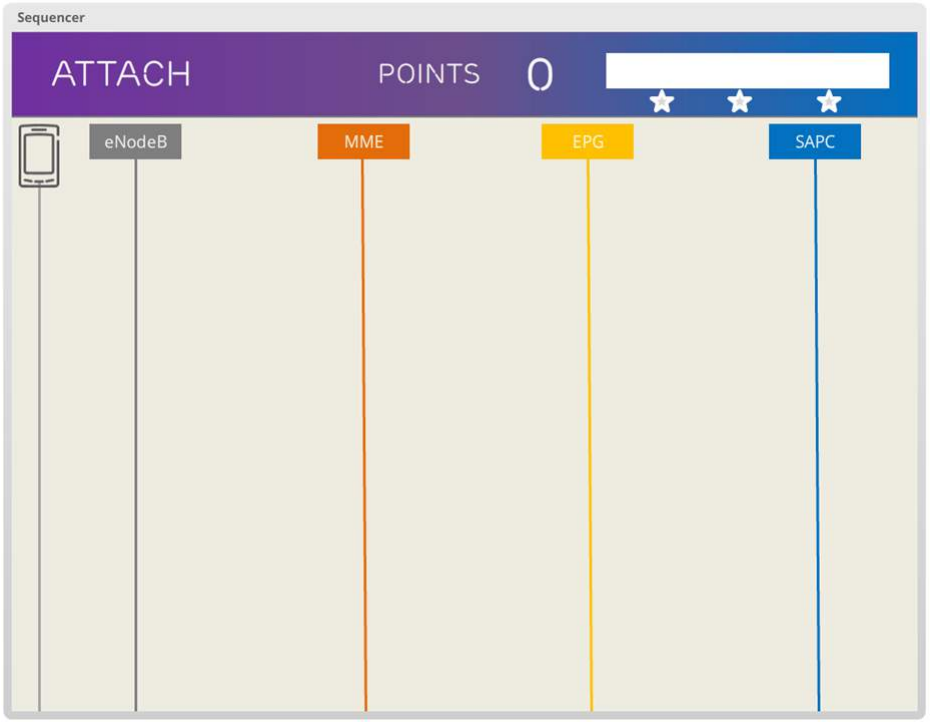

Figure 7.19: The game has started and the sequence diagram is empty.

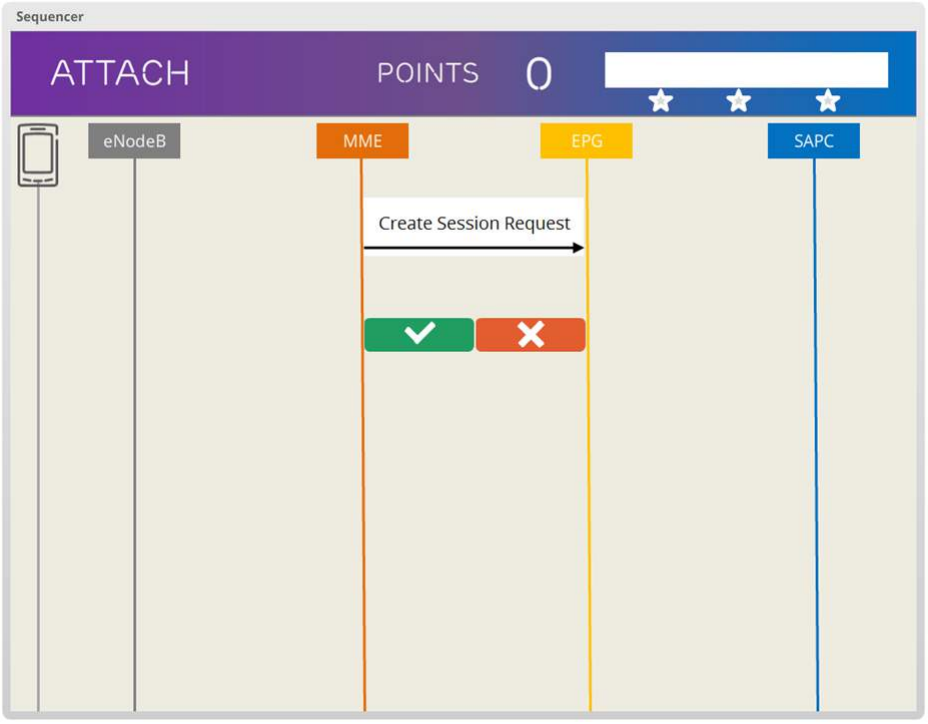

Figure 7.20: The first signals start to appear in the game.

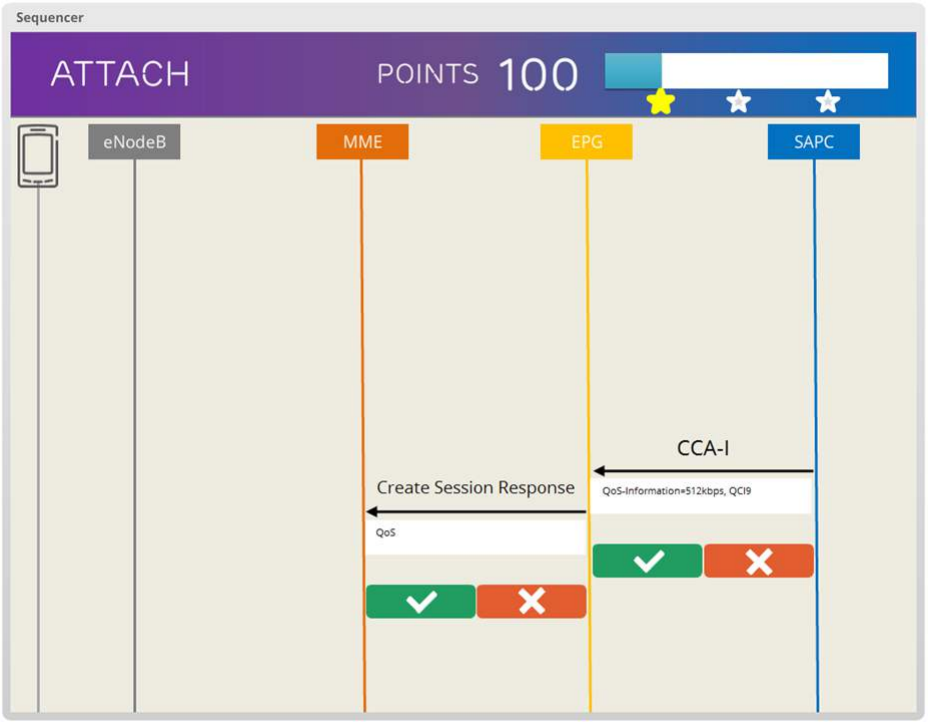

Figure 7.21: More signals and parameters appear in the diagram. The learner has received points and a star.

8

Discussion

As we have been developing the guidelines, game ideas and receiving feedback from employees, we have found certain aspects that are important to consider when designing for learning games.

8.1 Guidelines

The guidelines can be used to guide instructional designers or game designers when designing educational games. According to (Rogers et al. 2011), design principles or design guidelines are elicited from research, experience and common sense. Therefore, the guidelines we created are based on game research and design principles advocated by both academic and professional designers of educational games. We have also added a few guidelines based on the experience we gathered during this project and previous studies in interaction design. We regard these as advice rather than facts or limitations and they could help future designers to motivate their designs and also ease the design process.

In the first guideline iteration we chose to include some categories of guidelines that we wanted to create guidelines of. When categorizing the guidelines we used frameworks to guide us and help come up with more categories relevant to game design. We chose not to categorize guidelines for each game category since most of the guidelines can be used for designing educational games in general. If we were to divide guidelines into gamification guidelines, serious games guidelines and so on, many guidelines would have been repeated in several categories.

We chose to include motivational theory and emotional design in the guidelines since they are an essential part of game design. A guideline based on Self-determination theory (SDT) was added since most of the research used this study talk about motivation in games. However, we chose to not include The ARCS motivational theory as a guideline since it was better used as theory that supported our existing guidelines. ARCS is mainly used in educational settings and we wanted to and several of our existing guidelines had support in this theory.

A game that does not look finished can bring down the overall satisfaction of the game (Shelley 2001). Therefore, we added emotional design theory used in game design into the Aesthetics chapter in guidelines. This chapter could be developed when the game concepts have been

developed and when one can see what more theories might be useful when designing the look and feel of the game.

The guidelines could be used by people outside Ericsson as they are formulated now. However, there are a few guidelines that may not be useful. One such example is number 13 'Contextualize the learning experience'. The guideline itself may be applicable but examples we use to explain the guideline is more specific to Ericsson. To make the guidelines more usable even outside Packet Core we omitted references to Packet Core in the guidelines.

8.1.1 Validity of the guidelines

The guidelines have been tested at Ericsson. We have got feedback on them twice from an instructional designer at Global Services. Another instructional designer gave us positive feedback on them. We could have tested the guidelines even more but we were not able to do this due to scheduling problems. We also added guidelines of our own based on the experience we gained during developing concepts focus on Ericsson. When we got feedback from Ericsson on the game concepts we changed the guidelines as well. One such example was number 5 'Gather domain knowledge'.

The guidelines helped us to see problems with our designs more clearly. We also saw the need to add guidelines that were missing. For instance, we added guidelines for thinking about the context of learning, make use of learning objectives, flowchart and type of knowledge. When we had developed the concepts even more and went through the guidelines it helped us to verify that the existing guidelines were justified.

We see some problems with our guidelines. One of the problems is how much interaction design guidelines needs to be part of the guidelines. The focus of the guidelines was on the game design but interaction is certainly an essential part of game design. As mentioned earlier, the target group of the guidelines, as we see it, is educational game designers, instructional designers and interaction designers. Game designers and instructional designer may or may not have a background in interaction design and we chose to include some general principles that were important to consider when designing educational games regardless of their knowledge in interaction design guidelines. However, we decided not to add general user interface guidelines or guidelines for improving accessibility.

Another problem could be how we formulated the guidelines. We wrote them in a prescriptive manner since they usually come in that format as Rogers et al. (2011) suggests. As mentioned earlier, the guidelines are based on research but we formulated the guidelines as one sentence in a prescriptive manner in order to make it easier for the user of the guidelines to check if they had followed the guidelines or not. The wording of the guidelines could be improved with more usage of guidelines. We chose to add the word *consider* or *when appropriate* when the guidelines dependent on the context of use. Examples of this are 35. Use a suitable look and feel, 27. Consider using time pressure and 20. Consider design dilemmas. However, we chose to write "use learner-centered leaderboards". This was because the research and also we think that if the designer decides to have a leaderboard or set of leaderboards, they should

be learner-centered. We also chose to use the word *learner* instead of *player* in order to get the user of guidelines in the mindset of thinking about the learning context throughout the conceptualization process. Especially during the design of educational games the focus needs to be on learning even though fun is also an essential part of a game.

Some guidelines contradict other guidelines. One such example is guideline number 14 'Let the learner know what they will learn' and guideline number 15 'Throw the learner into immediate action'. Even though it is important to not bore the learner with a wall of text to read, he or she needs to know the context of learning in order to understand what is expected of the learner. We also added a guideline 'Consider design dilemmas' in order to make the designer or developer aware of contradictory research.

8.2 Game concepts

We have identified several different target groups and areas where games can be applied in internal training. As mentioned previously, a game can be played by new employees to get an understanding of what Packet Core works with. Games can also be played before a course to get basic understanding of its content or during/after a course to repeat the knowledge or get a deeper understanding of something. A game can also describe what Packet Core works with in a fun and interesting way to a non-Ericsson employee. As this project was about providing the groundwork for future projects, having these target groups and areas of application identified will help in the development. It enables Packet Core to see where games can be applied and what works and what does not work. It can help other designers to focus a game on pre-defined groups and contexts in which games already have been tested. We designed the games to be very different from each other and to be aimed towards different people and areas of application because we wanted to test their potential and how they were received.

EriSim and Sequencer received a lot of positive feedback throughout the project. They are very different in many aspects, for example target group, the look and feel, level of detail and category of games. EriSim is a serious game whereas Sequencer is a gamification of a sequence diagram. The employees are very used to reading those types of diagrams and Sequencer provides a new of interacting with a diagram, which is why, according to them, they find the game interesting. It contains much more detail compared to EriSim and is aimed towards another target group. However, EriSim is most often attracting people's attention, which we think is because of its look and feel. This was evident from the Hackathon when we observed several people stopping by to look at the EriSim scenarios, but did not look at other ideas. Also, EriSim has a much more game-like appearance compared to Sequencer. eWall has however not gained as much feedback as the other two games during the project. It might be because the target group of the game is not the same as the one that we have shown the game to. We have shown the game to employees at Packet Core to get feedback, but the game is aimed towards new employees or non-Ericsson employees. We did this because we wanted to get feedback from people who had knowledge about the network and the nodes. It felt important to get the game correct in that regard to the information it contained before playtesting on the target

group.

After the workshop follow-up we have realized the importance of providing a context for the learner. For example, designing the game based on a use case which we have done in Sequencer. In the current courses at Packet Core, use cases are always used to describe the functionality of the network nodes. By using the same approach in the games, the learner can see a resemblance between the traditional training and the games. The context becomes familiar to the learner between the two mediums and the games become a complementary medium of communication. It also makes it familiar to a teacher, who is used to the traditional approach, to apply a game to the course. We think the familiarity might encourage and make the employees at Packet Core more keen to incorporate the games in their training.

We have experienced that development of games takes time. One has to therefore consider when it is worth spending time on developing a game, and when it is better to go with the more traditional teaching approach. If the course content changes a lot, the game has to be changed as well, and redesigning the game takes time. We believe that games might be more appropriate to use for courses or information which are not changed that often, to minimize the need for redesigning.

8.2.1 Test vs learning

After the workshop we realized the potential of using test games in internal training at Packet Core. It opened up a whole new aspect for us of how games could be applied to training. The feedback received on the testing game was positive and people saw a need of having such a game in training to make it more motivating and engaging. As a result, the focus of the project was changed and made it even broader than it already was. The research question was changed to also include testing games. We consider it really important to be able to make this distinction between testing and learning games. Since it has been incorporated into the guidelines, it can provide more guidance in future development of games when the two areas have been identified.

However, our mindset has been focused on learning games since the outset of the project. It is difficult to say how much this mindset limited our research. One example was that we discarded quizzes and jeopardy games since the games themselves did not teach. This was a natural outcome since the research question and the title of the project contained the term ‘game-based learning’. If we would have had a different mindset however, those types of ideas might have been pursued earlier in the project and it might have changed the definition of the project. We asked ourselves if it would have helped to talk with the employees at Packet Core before the workshop to identify this distinction. Since it was the game Call of VoLTE (or Sequencer) that ignited the discussion about testing games, we do not think the distinction would have appeared without using that game as a mediating tool during the workshop.

Since the focus was to create learning games, the guidelines and the research behind them focused on how to design learning games. After realizing the distinction, we had to either find theory supporting testing games and add new guidelines, or to apply the existing guidelines on

the testing game as well. We decided to go with the latter and applied the existing guidelines to Sequencer to incorporate more learning into the game.

8.2.2 Design dilemmas

When developing the games, we encountered some design dilemmas that has to be taken under consideration when designing. One such dilemma was whether or not to show the learning objectives to the learner in the beginning of the game. Kapp (2013*a*) claims that one should inform the learner about what is to be taught in a game before starting to play. However, Kapp (2014*a*) claims the contrary and argues that the learner should be thrown into immediate action and not be shown a list of learning objectives. Similarly, to maintain mystery in the game, it should not reveal all the content from start. We struggled with how to tackle this issue. It seems necessary to find a balance on how much the learner needs to be informed before the start of the game. We feel however that it is difficult to find a balance where the learner is informed enough but still does not become bored.

Another dilemma is the use of time constraints in a learning game. Enders (2013) points to the benefits of using time to put the learner under pressure. However, when it comes to learning games, we have found that it is not always desirable since it can divert the focus from the actual learning. If the learner is under time pressure, there might not be enough time to read and reflect. The learner might instead skim through the text, skip steps or just guess when answering a question to complete the game within the time constraint.

We have also experienced difficulties about how much the game should provide risk taking and punish failure. Researchers argue that a game should incorporate risk taking and promote freedom to fail (Chatfield 2010, Kapp 2014*a*, Enders 2013, Fullerton et al. 2008). Kapp (2014*c*) agrees that the learner should be put at risks, but also points out that learning environments usually do not involve any risk taking. Hence, when designing games for training, the game should make the learner feel that something is at risk to engage and focus the learner with the task at hand (Kapp 2014*c*). Research has also shown that learning from mistakes is a powerful way to learn (Enders 2013).

Finding the right level of detail can also be complex when designing educational games. The information must be relevant to motivate people to learn (Keller 1987). Therefore, information, such as technical details, needs to match real-life constraints. One problem we encountered when designing EriSim was using money in the game. Realistic prices for nodes can be sensitive information that may not be public. Since pricing depends largely on the capacity and the hardware of the node and also geographical factors, it can be problematic to say that this kind of node will cost exactly this much. On the other hand, if the prices are too unrealistic a learner playing the game could not understand how expensive the nodes are.

Another problem is how realistic the technical game content needs to be. When designing the games, we experienced that it depended on the target group on how realistic the information should be or how much it can be simplified before it becomes too simplified and irrelevant. A

new employee may not need to know the signals and parameters of a use case but an employee working with troubleshooting needs to know more than that.

We have experienced an issue with the look and feel of games. Games can be regarded as childish or unserious to play during working hours. Some people have expressed that the games, especially EriSim and the games based on allegories, give a childish impression. However, others think the opposite and do not consider the game to be childish, even when we asked about it explicitly. Research on this point shows that childishness and unseriousness can be an issue at companies, and that the games need to be tested when used in that environment (Norman 2004, Kapp 2012). Therefore, we consciously designed the games to be different to test this, i.e. with different look and feel. EriSim is designed closest to what we consider to be a childish look, i.e. cartoon-like, to test it among the employees. Sequencer is on the other side of the spectrum and is designed with the most realistic, strict and serious appearance. In between these games lies eWall which represents the demo wall, which exists in real life, but is presented as a drawing or cartoon like image. The look and feel of the game is something that has to be taking under consideration when designing games, and it needs to be tested more to know which look that works for the different target groups. Several different look and feels can be tested to see if the graphics should be cartoon-like or more realistic. An interesting aspect to test would be to have different versions of the game with different look and feels to see which one that is suitable for the target group. It would also be interesting to see if there is a difference in perception of the game among people depending on their previous experiences of games. This thought arose after the user tests when we noticed that people perceived the games differently depending on the previous experience.

8.3 Prototype

As discussed earlier, the choice was between paper prototype and a digital prototype and the complexity of the digital prototype. We found out that a digital prototype was more suitable to implement since the limitations of a paper prototype outweighed the disadvantages of a digital prototype. Therefore the choice was between template-based authoring tool, game engines or programming languages. Since expectations and requirements of the target groups were to create a mobile learning experience the options were to look into web technologies that could be used on several different devices. We prototyped the idea that had the most potential and it was luckily easily implemented with a template-based authoring tool.

Even though the prototype was not the focus of this project, there was a wish to see how a prototype could work in Packet Core. There was also a need to playtest the game concepts and we decided that we would rather use a content editor tool such as Storyline over paper prototyping. There were several reasons for this. One reason was that time constraints of the game are harder to simulate on a paper prototype. Changing questions on paper would also obstruct was that changes to the prototype could be made. Therefore, the prototype was created to understand how employees could use and test how employees would react in a game setting. We also wanted to test two different version of interaction for Sequencer and since Storyline

did not allow version control, we created two versions of the game. One could argue that we should have focused on one of the ideas more thoroughly instead. However, testing the two versions gave us insights to what type of games that one could do with storyline and test the program's possibilities and limitations when it is used to create games.

Even though the prototype we created to user test was too stressful we observed the tester to be engaged in the game compared to some educational games that we had tested before. As mentioned above in the discussion of concepts, time in educational games is problematic when the game is too stressful but time can also create a sense of urgency that can motivate and grab the attention and focus of the learner.

8.4 Design process

The research question has been to look into design of educational game and how it can be in Packet Core, which means that the project is somewhere in between game design and instructional design. Since we have an interaction design background we used a process where we researched the game design field but also requirements and expectations from Packet Core and how they had implemented game-based learning earlier. Then it was decided to use Design Thinking promoted by IDEO. However, after some weeks it was evident that we used the same process as we had done before. The process we used was quite similar to the interaction design lifecycle process described by (Rogers et al. 2011). We started by researching games, educational games and Ericsson to be able to establish requirements, expectations and needs. Then we created the guidelines in order to help designing alternatives of game concepts. One of the concepts was prototyped and evaluated. In retrospect, we could have used either a game design process or an instructional design process. However, we see that there are more similarities between them and that the most important feature of all these processes is the need for iterations in each stage of the design process. As mentioned earlier we performed three replannings during the project. This was not unexpected at all since the research question was and still is a wicked problem. We anticipated revising the plan several times and making more detailed plannings to adapt to the changing circumstances.

The process of creating and developing guidelines alongside the conceptualization worked well for us, since learning from creating concepts helped us to develop guidelines and vice versa. Since we had problems creating guidelines before designing the concepts we started to create concepts earlier than planned as mentioned previously in chapter 6. Earlier conceptualization helped us look into guideline categories that we were lacking and helped restructure the guidelines and categories to mirror the game design process. For example, when we tried to design the concepts we wanted to know what kinds of questions we needed to answer in order to design for the target group we chose. The gamification course had already introduced us to the Gamification design framework, see section 2.4, and we had also looked into Bloom's taxonomy, types of knowledge and Kapp's question to define the requirements and needs of the game concepts we create for each course, see section 2.11. Even though we did not only look into gamification the questions in the Gamification design framework and Kapp's helped

us answer some of the core issues with our concepts and helped us evaluate after the brainstorming sessions. When designing the concepts, we checked them against our guidelines in order to incorporate more game mechanics and theories and also to see if the concepts were following the guidelines. This procedure helped us develop the concept even more and also helped us to develop and restructure the guidelines even more.

Even though we started looking into motivational design and emotional design in the beginning of the project, we could not see how to incorporate the theory in a natural way. We added some of the theories to our guidelines but we did not design the concepts. It is unclear whether we should have tried to incorporate more of these theories in the earlier stages of development but we found these theories more relevant more towards the end of the project when evaluating the game concept. The emotional and the motivational aspects of games are important to investigate but they are more relevant to look at when there already exists basic concepts and these theories can be used to develop the concepts even further.

8.5 Ethical issues

Depending on the gameplay and the implementation of our concept, it might be easy to cheat what you have learned so far. If the learners can manage to finish a digital course by just clicking without actually learning anything then that course is useless. To increase learning, the gameplay should increase the interaction between the teacher, the learners and the content of the course. The gameplay should only change the means of learning without changing the learning goal of the course.

Adding game mechanics to a current training course could be considered as unnecessary tasks, which requires additional time to complete. This has the risk of an increased stress level among the participants which could possibly affect their work performance. Transforming a course into a game-based learning activity is possibly considered to be unprofessional or even childish (Norman 2004). Participants may not regard the training delivered to them to be serious enough in such a well-established company when the word ‘game’ is used. We went to the hackathon and we have pitched the ideas and presenting for several different business units in order to make more people aware of games can be used in corporate environments and also to check the need and expectations from different business units.

8.6 Future work

This project provides a base of knowledge for future projects, consisting of research, guidelines and game ideas. We believe that research of pedagogy and learning aspects should be carried out in order to create a more extensive base. Those aspects are needed to include when designing games for internal training. More research of emotional and motivational theories should also be added to the base. By expanding the base of knowledge, the guidelines and game ideas

can be developed even further to include more aspects that are relevant for games in internal training.

The research can help developing the guidelines, but we believe that there is also a need to test them even more by applying them to games during development. New guidelines might appear to be important while others might seem less important after more extensive testing. The guidelines can also be improved by receiving feedback from experts in game design, pedagogy and instructional design. As such, designers can use a pre-made compilation of guidelines and apply them when developing. To make the guidelines easier to use when designing, a checklist can be included in which the designer can mark those that have been implemented.

By expanding the knowledge base and improving the guidelines, the game ideas can be improved as well. We think they should be playtested more extensively on the target group to get their feedback on gameplay, learning aspects and the look and feel. As mentioned previously, several different look and feels can be tested for one game to find one that is appropriate for the target group. Implementing one or several of the game ideas will give concrete examples that can provide more thorough tests in the environment where they should be used. The research and guidelines can be used to develop new game ideas to test on other target groups and in other areas of application. Adding references inside the games to Ericsson specific documentation will help the learner to find more information when needed.

One could also develop a game platform that provides a way to create games easier than developing them from scratch. The platform could provide modularity where the content of the games can easier be changed. It would save time on development since many elements of the games could already be implemented. It might also be cost efficient when time can be saved on the development. Having an interface which is easy to use makes it also possible for more people, not only designers, to create and change the games.

9
Conclusions

The research question was originally *How can game-based learning be implemented at Ericsson Packet Core for training purposes?*, but was later changed to *How can games be implemented at Ericsson Packet Core for training purposes?*. The first version excluded testing games which we realized was important to include after seeing their potential and usefulness in internal training at Packet Core. As the research question is a wicked problem, the understanding of it changed during the project and required us to expand the focus. We did however continue working in a similar manner and towards the same result, but was including testing games in the development.

To answer the research question of how games could be implemented at Ericsson Packet Core, a set of 37 guidelines, 15 game concepts and a prototype were created. The guidelines were developed iteratively throughout the project and feedback was received multiple times from employees with experience in instructional design. To test and evaluate the guidelines, game concepts were developed in parallel. Out of the 15 game concepts, three were chosen to be further developed. A prototype was developed for one of the games to get hands-on experience and to perform tests with learners from the target group.

The guidelines are based on an extensive research study performed in the beginning of the project. The majority of the guidelines is based on game research and design principles advocated by both academic and professional designers of games. Some were also elicited from the development of game concepts and from feedback received during the project. Although the guidelines have been developed close to Packet Core, they can be more general and be used outside of Ericsson for designing games for training.

The game concepts are developed based on the guidelines and the research study. Inspiration from existing games has influenced the development significantly. The game concepts can be used to test games in internal training at Packet Core. They can also aid in future development by providing a reference point and acting as mediating tools during discussions about game design.

A prototype was created to use as a proof of concept and to test one of the concepts. The goal was not to develop a finished game, but rather to choose one of the game concepts and to make a prototype of it. The prototype serves as an interactive prototype of the gameplay and

game mechanics to create a better understanding of the game concept and be used as a base for further playtesting and implementation.

Packet Core can together with Global Services use the groundwork which this project provides and take the next step in developing games for internal training. The groundwork is made up by the guidelines, the game concepts and the prototype which have been developed and tested in close collaboration with Packet Core and Global Services. Even though they are still in the early stages of development, they could be used for further development of internal training games at Ericsson.

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Appendices

A

First iteration of guidelines

Note, this document is not finished and may contain errors. No references are included to strengthen the statements, refer to 7.1 for the finished version of the guidelines.

Game Design

Progression

How to measure

Provide a way for learners to show off their progression to others, as a mean to drive competition.

Examples of game mechanics that can be used to measure progress

- Points - use for status indicators and unlocking course content
- Badges/Achievements - use to show non-linear progress
- Game levels - use to show linear progress
- Experience bars
- Leaderboards

Leaderboards

Create meaningful leaderboards that display the most important behaviors and activities for reaching the learning goal. Show where the learner stands in the rankings or where the learner's inner circle stands, do not just show the top performers. Keep the number of visible competitors low, focus on showing the people that are close to the learner in ranking (e.g. five above and five below). If the leaderboard does not refresh immediately, clearly communicate

the updating frequency of the leaderboard to the learners. Consider resetting the leaderboard at the end of each week to give everyone a fresh start.

Consider having multiple leaderboards to show progression

- Overall
- On individual tasks
- In each region or office location

Game Levels

Let learners level up only when they have actively participated in the experience and not only by completing the content. Levels can be used to chunk topics and lessons and each level should be tied to specific learning objectives.

Use levels to show what learners need to do or learn in order to level up. Design levels to increase in difficulty during the gameplay; levels can be designed in the following manner:

- First level or initial levels are the easiest and shows what the learners need to learn
- The second set of levels: let learners practice and apply the skills they have learned in the earlier levels
- The final level is the most difficult level and requires the knowledge from the earlier levels.

Using this approach the learners can be allowed to choose the right level and if they choose the wrong level they can easily change themselves.

Reward effort

Reward the learner for completing challenges/objectives and achieving the designated goals. Use rewards to motivate performance, not completion. The reward must be meaningful to the learners and be somewhat difficult to obtain. Increase the scale of rewards as they move forward in the game. Create rewards of different values and sizes within the context of game. Do not reveal all the rewards from the beginning, but instead show a subset of the rewards. Surprise rewards can create new dimension of motivation for the learners.

Gameplay Rules

Rules

Design the onboarding to the game a comfortable experience for the learners. They need to know the rules and gameplay before starting to play. Consider providing a tutorial or practise

round that does not affect the scoring, leveling or winning. Keep rules, scoring and leveling simple.

End conditions

Winning the game should primarily be the result of knowledge acquisition or creation. The game should not focus on "winning only" since learners can get a negative emotional experience if a learner loses early.

Goals and Challenges

Create multiple long- and short-term goals that are based on the instructional objectives. Keep the learner constantly engaged by breaking down a larger task into smaller sub-tasks which can be completed to earn points along the way. Also vary the length, difficulty and completion time of the challenges. Variety is important, but do not make the challenges too easy or too difficult. Show a reminder of the current objectives during gameplay.

Time-based activities

Consider using time-based activities to mimic real-life time constraints.

Randomness

Provide an element of uncertainty, i.e. chance and random events (uncertain rewards etc.). However, it might be inappropriate if the game should respond to the learner's conscious decisions rather than chance.

Collaboration

If possible, create a game so learners must work in groups.

Gameplay

Freedom to fail

The game should incorporate risk taking and promote freedom to fail by

- Provide the opportunity to try again until learner has achieved the goal and mastered the content
- Give positive instructional feedback when the learner fails

- Award points for how well the learner is meeting the goals
- Do not punish failure.
- Put the learner at mock risk, e.g. Hangman

Designing Content for Learning

Learning objectives

The game should be designed to support specific and clear learning objectives. When mixing the game mechanics with the content, you should always be able to answer how it aids in learning.

Use the following structure to inform the learner about the learning objectives:

1. Briefing - State the learning goals in the beginning of the game
2. Feedback - Provide rapid, frequent and clear feedback throughout the learning experience, do not wait until the end. The feedback should be regarding the learner's behavior and actions, not on the learner's ability to temporarily remember or recognize information. Use a point system to give instructive feedback and show the progression in relation to the learning goals.
3. Debrief - Highlight the learning outcomes when the game is over.

Part of a larger structure

Implement a game as one component within a larger training strategy.

Learner in control

Give the learner meaningful choices and control over the learning. Let the learner choose where to enter the learning.

Interactive experience

The game should provide an interactive experience and focus on learner activities. Promote an active experience, not a passive experience.

Matching Game Strategy with Content Type

A table showing the definition of different content types, appropriate strategies when designing games and examples of games.

Type of knowledge	Definition	Appropriate strategy	Tell-tale verbs	Examples
Declarative	Factual information that can only be learned through memorization	Mnemonics Elaboration Association	Identify Recognize Recall	Trivia Drag and Drop Memory Jeopardy
Conceptual	Grouping of ideas, objects having common attributes	Metaphors Examples Concept Map	Classify Discriminate Compare Matching and sorting	Wack a Mole
Procedural	Step-by-step instructions for performing a task	Start with the big picture Teach "how"s and "why"s	Verify Perform Follow	Pizza Hero
Problem Solving	Previously unencountered situation	Multiple examples Question Protocol Learning Documentary	Construct Create Design	America's Army

Figure A.1: A table including types of knowledge and types of learning which can be matched up with different learning strategies.

Motivation

Intrinsic motivation

Design the game to engage people through intrinsic motivations. Avoid using only extrinsic motivations.

Examples of factors that contribute to intrinsic motivations

- Challenge
- Curiosity
- Control
- Fantasy - enable learners think out of the box and forget real-life constraints or fears
- Cooperation

- Competition
- Recognition

Elements that contribute to flow

- Achievable Task
- Control Over Actions (Autonomy)
- Clear Goals
- Concentration

Game Aesthetics

Stories and Characters

1. Set the scene
2. Create a compelling plot and present the conflict the learner tries to solve with the game. Learning objectives should be embedded in the conflict

Story

Create story that increases mystery and curiosity by only revealing parts of information. For example, if it is a treasure hunt game, hints and mystery can reveal information about the location of treasure rather than revealing the location from the beginning of the game. Reveal parts of the map throughout the game. The gap between unknown and known information creates a mystery that the learners immerse in.

Create a novel and exciting game to evoke curiosity.

Characteristics that enhance mystery:

- Novelty
- Complexity
- Inconsistency
- Surprise
- Incomplete information
- Inability to predict the future

Characters

Consider using several characters that learner can relate to, each providing a different type of knowledge or support. For example, one character can be the instructor and another character can be a mentor for the learner. Let the characters involve the learners emotionally. Make sure that the character should use an appropriate tone of voice that suits the learning experience.

Do not focus the gameplay around leveling up a character.

Fun

Examples of game mechanics that can add fun to the game:

- Pattern recognition
- Collecting
- Surprise and Delight
- Organizing and creating order
- Gifting
- Recognition for achievement
- Leading other
- Being the hero
- Gaining status

B

Second iteration of guidelines

Note, this document is not finished and may contain errors. No references are included to strengthen the statements, refer to 7.1 for the finished version of the guidelines.

Pre-design

Decide on what you are teaching

Make a list of

- Terminal learning objective(s) (TLO) - Overall goal with the course
- Enabling learning objective(s) (ELO) - Goal for each step to reach the TLO

Organize learning objectives

Organize the learning objectives into a flowchart. Show them in the order in which they should be learned and connect them to one another to illustrate a flow. Use the chart to create other flows or storylines that run in parallel.

Structure learning objectives

For each learning objective, decide the type of learning (Bloom's Taxonomy), type of knowledge and appropriate game mechanics.

Pick a game genre

Some popular game genres are:

- Driving/racing games

- Platform games
- Puzzle games
- Real-time strategy games
- Role-playing games
- Social/Casual Games
- Survival games
- Stealth games
- Tower Defense

Game Design

Measure progress

Provide a way for learners to show off their progression to others, as a mean to drive competition.

Examples of game mechanics that can be used to measure progress

- Points - use for status indicators and unlocking course content
- Badges/Achievements - use to show non-linear progress
- Game levels - use to show linear progress
- Experience bars
- Leaderboards

Use player-centered leaderboards

Create meaningful leaderboards that display the most important behaviors and activities for reaching the learning goal. Show where the learner stands in the rankings or where the learner's inner circle stands, do not just show the top performers. Keep the number of visible competitors low, focus on showing the people that are close to the learner in ranking (e.g. five above and five below). If the leaderboard does not refresh immediately, clearly communicate the updating frequency of the leaderboard to the learners. Consider resetting the leaderboard at the end of each week to give everyone a fresh start.

Consider having multiple leaderboards to show progression

- Overall

- On individual tasks
- In each region or office location

Divide content into levels

Let learners level up only when they have actively participated in the experience and not only by completing the content. Levels can be used to chunk topics and lessons and each level should be tied to specific learning objectives.

Use levels to show what learners need to do or learn in order to level up. Design levels to increase in difficulty during the gameplay; levels can be designed in the following manner:

- First level or initial levels are the easiest and shows what the learners need to learn
- The second set of levels: let learners practice and apply the skills they have learned in the earlier levels
- The final level is the most difficult level and requires the knowledge from the earlier levels.

Using this approach the learners can be allowed to choose the right level and if they choose the wrong level they can easily change themselves.

Reward effort

Reward the learner for completing challenges/objectives and achieving the designated goals. Use rewards to motivate performance, not completion. The reward must be meaningful to the learners and be somewhat difficult to obtain. Increase the scale of rewards as they move forward in the game. Create rewards of different values and sizes within the context of game. Do not reveal all the rewards from the beginning, but instead show a subset of the rewards. Surprise rewards can create new dimension of motivation for the learners.

Gameplay Rules

Rules should be simple to learn

Design the onboarding of the game to a comfortable experience for the learners. They need to know the rules and gameplay before starting to play. Consider providing a tutorial or practise round that does not affect the scoring, leveling or winning. Keep rules, scoring and leveling simple.

Learning means winning

Winning the game should primarily be the result of knowledge acquisition or creation. Avoid making the learner lose early since that can cause a negative emotional experience.

Incorporate several goals and challenges

Create multiple long- and short-term goals that are based on the learning objectives. Keep the learner constantly engaged by breaking down a larger task into smaller sub-tasks which can be completed to earn points along the way. Also vary the length, difficulty and completion time of the challenges. Variety is important, but do not make the challenges too easy or too difficult. Show a reminder of the current objectives during gameplay.

Time can simulate real life

Consider using time-based activities to mimic real-life time constraints.

Include randomness

Provide an element of uncertainty, i.e. chance and random events (uncertain rewards etc.). However, it might be inappropriate if the game should respond to the learner's conscious decisions rather than chance.

Get learners to collaborate

If possible, create a game so learners must work in groups.

Gameplay

Let them fail but do not punish failure

The game should incorporate risk taking and promote freedom to fail by

- Provide the opportunity to try again until learner has achieved the goal and mastered the content
- Give positive instructional feedback when the learner fails
- Award points for how well the learner is meeting the goals
- Do not punish failure.
- Put the learner at mock risk, e.g. Hangman

Design for Learning

Let them know what they will learn

The game should be designed to support specific and clear learning objectives. When mixing the game mechanics with the content, you should always be able to answer how it aids in learning.

Use the following structure to inform the learner about the learning objectives:

1. Briefing - State the learning goals in the beginning of the game
2. Feedback - Provide rapid, frequent and clear feedback throughout the learning experience, do not wait until the end. The feedback should be regarding the learner's behavior and actions, not on the learner's ability to temporarily remember or recognize information. Use a point system to give instructive feedback and show the progression in relation to the learning goals.
3. Debrief - Highlight the learning outcomes when the game is over.

Make the game complementary to internal training

Implement a game as one component within a larger training strategy.

Put the learner in control

Give the learner meaningful choices and control over the learning. Let the learner choose where to enter the learning.

Create an interactive experience

The game should provide an interactive experience and focus on learner activities. Promote an active experience, not a passive experience.

Throw the learner into immediate action

In the beginning of the game, use action, or an activity, to draw in the learner and encourage further engagement, do not just focus on learning content.

Matching game strategy with content type

A table showing the definition of different content types, appropriate strategies when designing games and examples of games.

Type of knowledge	Definition	Appropriate strategy	Tell-tale verbs	Examples
Declarative	Factual information that can only be learned through memorization	Mnemonics Elaboration Association	Identify Recognize Recall	Trivia Drag and Drop Memory Jeopardy
Conceptual	Grouping of ideas, objects having common attributes	Metaphors Examples Concept Map	Classify Discriminate Compare Matching and sorting	Wack a Mole
Procedural	Step-by-step instructions for performing a task	Start with the big picture Teach "how"s and "why"s	Verify Perform Follow	Pizza Hero
Problem Solving	Previously unencountered situation	Multiple examples Question Protocol Learning Documentary	Construct Create Design	America's Army

Figure B.1: A table including types of knowledge and types of learning which can be matched up with different learning strategies.

Motivation

Intrinsic motivation is key

Design the game to engage people through intrinsic motivations. Avoid using only extrinsic motivations.

Examples of factors that contribute to intrinsic motivations

- Challenge
- Curiosity
- Control
- Fantasy - enable learners think out of the box and forget real-life constraints or fears
- Cooperation

- Competition
- Recognition

Elements that contribute to flow

- Achievable Task
- Control Over Actions (Autonomy)
- Clear Goals
- Concentration

Game Aesthetics

Use stories and characters

1. Set the scene
2. Create a compelling plot and present the conflict the learner tries to solve with the game. Learning objectives should be embedded in the conflict

Create a compelling story

Create story that increases mystery and curiosity by only revealing parts of information. For example, if it is a treasure hunt game, hints and mystery can reveal information about the location of treasure rather than revealing the location from the beginning of the game. Reveal parts of the map throughout the game. The gap between unknown and known information creates a mystery that the learners immerse in.

Create a novel and exciting game to evoke curiosity.

Characteristics that enhance mystery:

- Novelty
- Complexity
- Inconsistency
- Surprise
- Incomplete information
- Inability to predict the future

Bring the story to life with characters

Consider using several characters that learner can relate to, each providing a different type of knowledge or support. For example, one character can be the instructor and another character can be a mentor for the learner. Let the characters involve the learners emotionally. Make sure that the character use an appropriate tone of voice that suits the learning experience.

Do not focus the gameplay around leveling up a character.

Make it fun

Examples of game mechanics that can add fun to the game:

- Pattern recognition
- Collecting
- Surprise and Delight
- Organizing and creating order
- Gifting
- Recognition for achievement
- Leading others
- Being the hero
- Gaining status

C

Third iteration of guidelines

Note, this document is not finished and may contain errors. No references are included to strengthen the statements, refer to 7.1 for the finished version of the guidelines.

Pre-design

Make sure you have correct information

Before initiating the design phase, you should have gathered all information which the course should include. Make sure that you have understood the course content correctly by confirming with a course responsible. Throughout the design, assure that the content is correctly described.

Decide on what you are teaching

Make a list of

- Terminal learning objective(s) (TLO) - Overall goal with the course
- Enabling learning objective(s) (ELO) - States the steps in accomplishing the TLO

TLOs and ELOs are written from the perspective of what the learner will do, not what the instructor will do. They should be precise, unambiguous and state the requirement in clear, direct language.

Example

TLO: After completing the game, a learner has acquired a basic knowledge of the nodes in both voice and data transfer networks and how they interact with each other to be able to continue the learning elsewhere.

ELO:

1. Understand the similarities and differences between the 2G (GSM), 3G (WCDMA) and 4G (LTE) networks
2. Identify and understand the nodes' functions in the Packet Core Network
3. Identify and understand the relationships between the nodes
4. Build a Packet Core Network of nodes and relationships
5. Identify the difference between voice and data transfer networks

Organize learning objectives

Create a flowchart, tree diagram or another form of diagram using the objectives to see the connections between the objectives. Understanding the flow of the game can help apply game mechanics, planning levels at later stage of the design process. Use the chart to create other flows or storylines that run in parallel. The diagram can also help to see which objectives depend on each other.

Structure learning objectives

For each learning objective, decide the type of knowledge and appropriate game mechanics.

Matching game strategy with knowledge type

A table showing the definition of different knowledge types, appropriate strategies when designing and examples of games.

Type of knowledge	Definition	Appropriate strategy	Tell-tale verbs	Examples
Declarative	Factual information that can only be learned through memorization	Mnemonics Elaboration Association	Identify Recognize Recall	Trivia Drag and Drop Memory Jeopardy
Conceptual	Grouping of ideas, objects having common attributes	Metaphors Examples Concept Map	Classify Discriminate Compare Matching and sorting	Wack a Mole
Procedural	Step-by-step instructions for performing a task	Start with the big picture Teach "how"s and "why"s	Verify Perform Follow	Pizza Hero
Problem Solving	Previously unencountered situation	Multiple examples Question Protocol Learning Documentary	Construct Create Design	America's Army

Figure C.1: A table including types of knowledge and types of learning which can be matched up with different learning strategies.

Example

Here is an example of a table that for each ELO lists the type of knowledge and game mechanics that can enable learning.

ELOs	Type of knowledge	Type of learning	Mechanics
Understand the similarities and differences between the 2G (GSM), 3G (WCDMA) and 4G (LTE) networks	Conceptual	Understanding	Missions, time perspective, resources
Identify and understand the nodes in the Packet Core Network	Declarative	Understanding	Action points, collecting

Figure C.2: Match ELOs with type of knowledge, type of learning and game mechanics.

Decide whether to test or teach

Decide if the game should test or teach knowledge.

A game to test

- Have a good understanding of the prerequisite knowledge.
- If the purpose is to evaluate skills, make a game that is closer to a simulation of the real world.
- If the purpose is to test declarative knowledge, the game could be more abstract.

A game to teach

- Break down the learning objectives into components knowledge, skill and attitude (KSA) and match them with game mechanics.

Knowledge, skill and attitude (KSA)

Knowledge - What terms and process should the learner learn? Example: Differences between nodes, names of the nodes, what each node does, difference between voice and data networks.

Skill - Skills that need to be learned. Skills should be modeled in games to mimic real world behaviour Example: Let the learner build the network using nodes as building blocks to understand the logical representation of the network

Attitude - Is there an attitude that the learner should get after a finished game? Example: Wanting to learn more about the nodes in the network

Pick a game genre

Some popular game genres are:

Platform games
: Description: Games in which the learner controls an avatar and jumps between platforms and over obstacles to advance in the game.
Examples: Super Mario Bros., Dustforce, Equalize.

Puzzle games
: Description: Games that features puzzle solving to test skills such as logic, pattern recognition and sequence solving.
Examples: Tetris, Portal, Candy Crush.

Real-time strategy games
: Description: Games that involves resource gathering, base building and control of units. They are not turn-based and are typically viewed from above.
Examples: Civilization, StarCraft, Age of Empires.

Role-playing games
: Description: Games in which learners take on the role of a character and perform actions

within a narrative and a set of rules.
Examples: Pokemon Red/Blue, World of Warcraft, Diablo II.

Social/Casual Games
Description: Games with simple rules that do not require a long-term time commitment nor a special skill to play. They allow or require social interaction between the learners.
Examples: FarmVille, Quizkampen, Ruzzle.

Tower Defense
Description: A sub-genre to real-time strategy games where the goal is to stop the enemies from reaching a specific point on the map by building towers that shoot at them as they pass.
Examples: Kingdom Rush, Plants vs. Zombies, Defence Grid.

See more genres listed by Mark Wolf.

Create a scenario

Create a set of images describing each step in a scenario of the game. This can help in making ideas more concrete, finding potential problems and mediating the discussion around game mechanics. The images could include sketches of the game or interface and with short explanations.

Design for Learning

Make the game complementary to internal training

Implement a game as one component within a larger training strategy.

Contextualize the learning experience

Investigate if the learner needs to understand the context in order to be able to under learning objective. Separating the context from the learning objectives can obstruct learning and understanding.

Example

Explaining each node separately without showing how nodes are connected to each other and why can make it difficult for the learner to understand why each node does what it does.

Let them know what they will learn

The game should be designed to support specific and clear learning objectives. When mixing the game mechanics with the content, you should always be able to answer how the they enable learning.

Use the following structure to inform the learner about the learning objectives:

1. Briefing - State the learning goals in the beginning of the game
2. Feedback - Provide rapid, frequent and clear feedback throughout the learning experience, do not wait until the end. Use a point system to give instructive feedback and show the progression in relation to the learning goals.
3. Debrief - Highlight the learning outcomes when the game is over.

Throw the learner into immediate action

Even though the learner needs to know the learning content, the learner should not be bored from the start. In the beginning of the game, use action, or an activity, to draw in the learner and encourage further engagement. The first few minutes determine whether learner wants to proceed in the game.

Put the learner in control

Give the learner meaningful choices and control over the learning. Let the learner choose where to enter the learning.

Divide content into levels

Let learners level up only when they have actively participated in the game.Eg: Do not let the learner just click next or guess one alternative in order to proceed in the game. Instead, the learner should use acquired knowledge to be able to level up. Levels can be used to chunk topics and lessons and each level should be tied to specific learning objectives. Use levels to show what learners need to do or learn in order to level up. Design levels to increase in difficulty during the gameplay; levels can be designed in the following manner:

- First level or initial levels are the easiest and shows what the learners need to learn
- The second set of levels: let learners practice and apply the skills they have learned in the earlier levels
- The final level is the most difficult level and requires the knowledge from the earlier levels.

The learners should be allowed to choose the right level and if they choose the wrong level they can easily change themselves.

Create an interactive experience

The game should provide an interactive experience and focus on learner activities. Promote an active experience, not a passive experience.

Game Design

Show progress

Provide a way for learners to show off their progression to others, as a mean to drive competition.

Examples of game mechanics that can be used to measure progress

- Points - use for status indicators and unlocking course content
- Badges/Achievements - use to show non-linear progress
- Game levels - use to show linear progress
- Experience bars
- Leaderboards

Use player-centered leaderboards

Create meaningful leaderboards that display the most important behaviors and activities for reaching the learning goal. Show where the learner stands in the rankings or where the learner's inner circle stands, do not just show the top performers. Keep the number of visible competitors low, focus on showing the people that are close to the learner in ranking (e.g. five above and five below). If the leaderboard does not refresh immediately, clearly communicate the updating frequency of the leaderboard to the learners. Consider resetting the leaderboard at the end of each week to give everyone a fresh start.

Consider having multiple leaderboards to show progression

- Overall
- On individual tasks
- In each region or office location

Reward effort

Reward the learner for completing challenges/objectives and achieving the designated learning goals. Use rewards to motivate performance, and not completion. The reward must be meaningful to the learners and be somewhat difficult to obtain. Increase the scale of rewards as they move forward in the game. Create rewards of different values and sizes within the context of game. Do not reveal all the rewards from the beginning, but instead show a subset of the rewards. Surprise rewards can create new dimension of motivation for the learners.

Gameplay Rules

Rules should be simple to learn

Design the onboarding of the game to a comfortable experience for the learners. They need to know the rules and gameplay before starting to play. Consider providing a optional tutorial or practise round that does not affect the scoring, leveling or winning. Keep rules, scoring and leveling simple.

Learning means winning

Winning the game should primarily be the result of knowledge acquisition or creation. Avoid making the learner lose early since that can cause a negative emotional experience.

Incorporate several goals and challenges

Create multiple long- and short-term goals that are based on the learning objectives. Keep the learner constantly engaged by breaking down a larger task into smaller sub-tasks which can be completed to earn points along the way. Also vary the length, difficulty and completion time of the challenges. Variety is important, but do not make the challenges too easy or too difficult. Show a reminder of the current objectives during gameplay.

Time can simulate real life

Time can create a sense of urgency within the learners and make them prioritize tasks and create a fun experience (or a negative one by inducing stress). Consider using time-based activities to mimic real-life time constraints.

Include randomness

Provide an element of uncertainty, i.e. chance and random events (uncertain rewards etc.). However, it might be inappropriate if the game should respond to the learner's conscious decisions rather than chance. Randomness can make the game more replayable but use random events with caution.

Try to avoid perfect communication

Another example is communication, which often is perfect (i.e., without delays and misunderstandings, etc.) in entertainment games, whereas some serious training applications should rather reflect that communication seldom is perfect.

Get learners to collaborate

If possible, create a game in which several learners must work in groups to solve a task. Groups facilitate learning better than individual game play. See examples of Social/Casual games under Pre-Design.

Let learners fail but do not punish failure

The game should incorporate risk taking and promote freedom to fail by

- Provide the opportunity to try again until learner has achieved the goal and mastered the content
- Give positive instructional feedback when the learner fails
- Award points for how well the learner is meeting the goals
- Do not punish failure too much.
- Put the learner at mock risk, e.g. Hangman

Motivation

Intrinsic motivation is key

Design the game to engage people through intrinsic motivations. Avoid using only extrinsic motivations.

Examples of intrinsic motivators: depends on the person but it could be fame, challenge, sense of control, sharing experiences with others Examples of extrinsic motivators: salary, points, badges, certificates

Examples of factors that contribute to intrinsic motivations

- Challenge
- Curiosity
- Control
- Fantasy
- Cooperation
- Competition
- Recognition by others

Elements that contribute to flow (the state in which the learner's ability and game difficulty are balanced effectively)

- Achievable Task
- Control Over Actions (Autonomy)
- Clear Goals

Game Aesthetics

Use stories and characters

1. Set the scene
2. Create a compelling plot and present the conflict the learner tries to solve with the game. Learning objectives should be embedded in the conflict

Create a compelling story

Create story that increases mystery and curiosity by only revealing parts of information. For example, if it is a treasure hunt game, hints and mystery can reveal information about the location of treasure rather than revealing the location from the beginning of the game. Reveal parts of the map throughout the game. The gap between unknown and known information creates a mystery that the learners immerse in.

Create a novel and exciting game to evoke curiosity.

Characteristics that enhance mystery:

- Novelty
- Complexity
- Inconsistency
- Surprise
- Incomplete information
- Inability to predict the future

Bring the story to life with character(s)

Consider using several characters that learner can relate to, each providing a different type of knowledge or support. For example, one character can be the instructor and another character can be a mentor for the learner. Let the characters involve the learners emotionally. Make sure that the character use an appropriate tone of voice that suits the learning experience. Do not focus the gameplay around leveling up a character.

Make it fun

Examples of game mechanics that can add fun to the game:

- Pattern recognition
- Collecting
- Surprise and Delight
- Organizing and creating order
- Rewards (easter eggs, unlocking levels)
- Recognition for achievement
- Leading others
- Being the hero
- Gaining status

Player types

Think about game types when designing games to create a game experience that attracts several player types.

Amy Jo Kim's revised player types (based on Bartle's player types)

When designing casual, social and educational games check if your game attracts several player types.

Explorers

- Motivated by discovering the ins-and-outs in the game world as well as accumulating and showing off knowledge.
- Love to challenge the game world.
- Value accurate info, clever design, and relationship-building via knowledge exchange.

Consider the following to gain explorers' attention:

- Create an environment that can be explored with loopholes with a clear system of rules.
- Allow for single player mode.

Creators

- Motivated by opportunities for self-expression.
- Love tools and systems that let them personalize their experience, make their mark, and express their uniqueness.
- Value originality, creativity, hard work, and personal style.

Consider the following to gain creators' attention:

- Let them customize backgrounds, fonts and avatars.

Competitors

- Motivated by testing their skills and seeing how they stack up.
- Love to develop their skills and know where they stand within a group.
- Value mastery, learning, and relationship-building via friendly competition.

Consider the following to gain competitors' attention:

- Create external ranking systems.

Collaborators

- Motivated by working with others towards a greater goal
- Love to "win together" and measure success as collective impact.
- Value teamwork, shared learning, and relationship-building via shared tasks.

Consider the following to gain collaborators' attention:

- Create a co-op game or add game elements that encourages forming partnerships or teams.

Types of Fun

1. Sensation - Game as sense-pleasure
2. Fantasy - Game as make-believe
3. Narrative - Game as drama
4. Challenge - Game as obstacle course
5. Fellowship - Game as social framework
6. Discovery - Game as uncharted territory
7. Expression - Game as self-discovery
8. Submission - Game as pastime

Charades: Fellowship, Expression, Challenge.

Quake: Challenge, Sensation, Competition, Fantasy.

The Sims: Discovery, Fantasy, Expression, Narrative.

Final Fantasy: Fantasy, Narrative, Expression, Discovery, Challenge, Submission.

D

Complete list of game ideas

Note, this list does not contain the game ideas that were developed further. Refer to 7.2 for a description of those.

Nodify

The game is a collection of smaller serious games, one for each network node. Each game illustrates the function of a node. For instance, in the game for a node which sorts data packets, the learner controls the path of packets so they end up in the correct location.

The nodes' main function is illustrated in a way which is different from reality to help the player remember. Points are rewarded dependent on the player's performance in each game

The two images below are alternatives of illustrating a node which sorts packets.

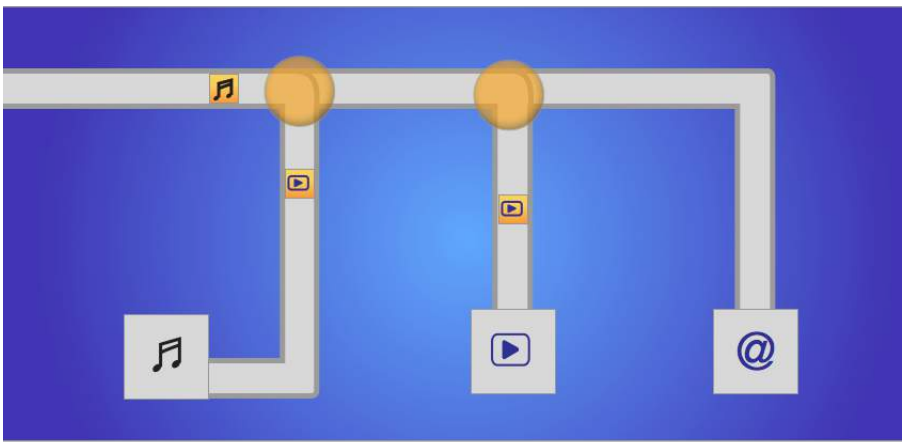

Figure D.1: The learner can control the direction of the packets by clicking on the orange circles.

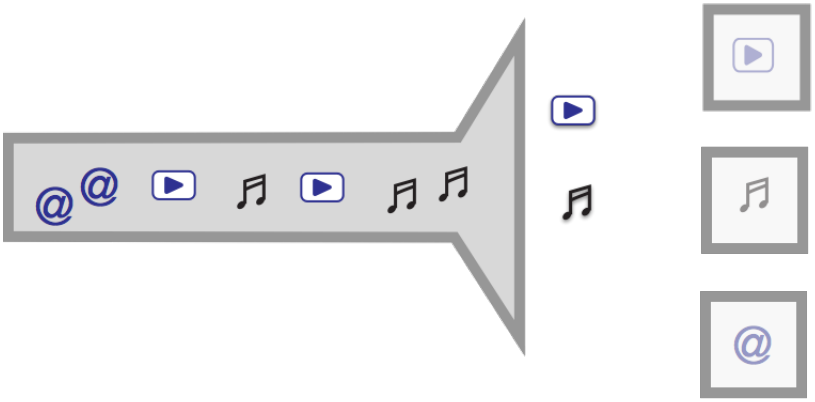

Figure D.2: The learner can drag the packets to the correct location as they leave the rectangle.

This image is for a node which function is to keep track of in which antenna the user equipment

is located.

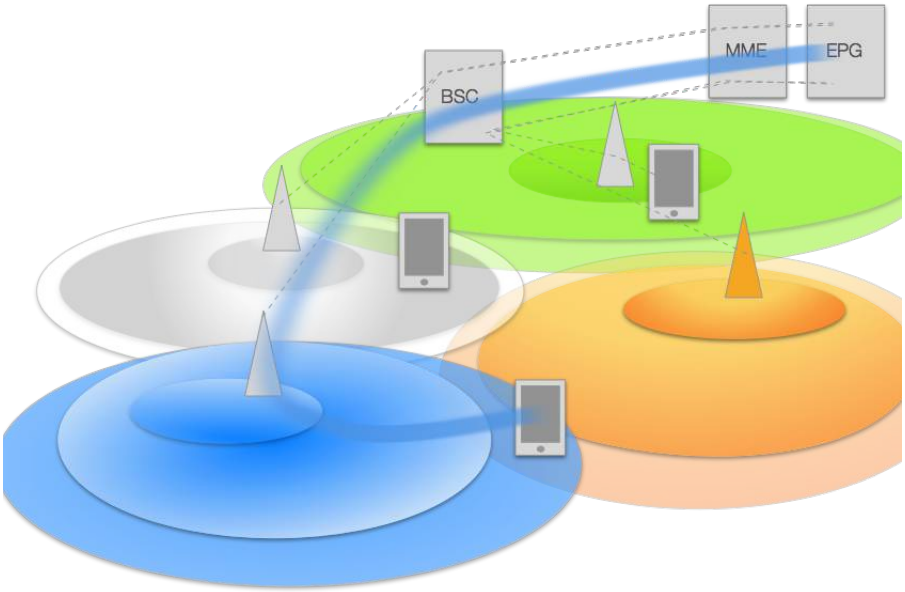

Figure D.3: When the user equipment moves into a new antenna, the learner can drag a line from the user equipment to the node so that it tracks the location.

The wall

There are several ways to visualize the demo wall better and create a better understanding of what it demonstrates. To do this one does not necessarily need to create games. Examples of how to make the demo wall more interactive: Adding a button that triggers subtle light flow through the flow from the use equipment to Internet. People passing by could get interested by the flowing lights to get more interested to learn more. Tablet at each node that one could interact with and read about the nodes. Role play the nodes by using a collaborative app which could be downloaded Competing with each other using a game that could be downloaded Augmented reality A mobile application that uses the phone camera to provide an information overlay Google Glass/Oculus Rift that can be borrowed to get an information overlay

Find competence

An application in which the players register their area of competence and can gain reputation by answering question within those areas. A player can search for other people and see their reputation count. After choosing a person who seems to be able to answer the question, based

on the reputation, the player goes to that person. When receiving an answer, they both use the app to perform a "handshake" (e.g. using a QR-code) so that the person gains reputation by answering the question. The app encourages people to go and ask questions and people are rewarded for answering them. A person might get to know new people by asking those with high reputation, and not only those the person already knows.

The application might include a feature for creating a session (for a certain event) where the people attending can login and see who else is participating and what knowledge are present at the session.

Find a room

To learn the location of different rooms, games could be created that could be played when you start at Ericsson. One example would be to create a trivia game in which the answers to question lie in different rooms in the Ericsson building. To answer a question the player needs to locate the room and scan a QR code placed in the room.

Another idea would be to create a story that ties the rooms together to create a memory palace for the player in order to find the rooms easier. The story could be to find a special item or a person. The name of the person or the item should then be related to the name of the room.

Find nodes

Nodes and masts are placed around cities and their existence is unknown until somebody tells what their functions are and where you could find them, for instance a radio base station. To visualize the existence of Ericsson products, a pervasive mobile game (similar to Geocaching) can be created. The goal of the game can be to find masts, nodes in the town of Gothenburg. The player has a map of the city and clues on where to find masts and nodes. When the GPS position of the player's mobile matches the location of the correct node or mast, points are awarded.

Ericsson quiz

A quiz game (similar to Quizkampen, QuizUp or Jeopardy) in which players answer questions related to Ericsson. The players can choose different levels and categories and gain ranking which are shown in a leaderboard to promote competition. The players can also send in their own questions to make the content user-generated.

Gamify the learning process at Ericsson

To make self-learning more interesting, internal training courses could be a part of a larger system which is gamified. The design could take inspiration of Stack Overflow and have a reputation counter that increases when the learner moves on to learning more difficult courses. The reputation counter could be incorporated with Ericsson' learning platform.

Water network

A game using allegories to illustrate the data flow in the network with water flowing through lakes, rivers and dams. The player can control the water flow to represent the nodes' functions.

Network body

A game using allegories to illustrate the network and the nodes with a human body. The nodes can be represented by different body parts what are connected in different ways. The player can control the data flow between the nodes and will use the body to help remembering how the nodes are connected.

Be the packet

Experience the packet's world by controlling it through the nodes in a network in a first-person view. The nodes can be huge buildings and the cables are roads to travel on. The world can be designed to represent the functions of the nodes. The player can pick up and deliver parameters between nodes.

Network simulator

A game that simulates a complete network and everyone needs to collaborate to build a working network. Employees from different divisions need to use their area of competence to get every part of the network working. This game idea could be inspired by Minecraft.

Hexagons

Take the role of an operator and try to cover a geographical area with masts, represented by hexagons, to meet an objective. An example objective could be to give 4G coverage to

everyone in a city. The player has money that has to be managed to cover a sufficient area with masts.

E

Usability Testing

Background information

Age/Gender For how long have you worked in the Telecommunication Industry?

The test scenario

Scenario: You are attending a course in Signaling and you get to learn the Attach use case. (Show sequence diagram). The instructor gives you a link to perform a test of how much you remember from the Attach use case. Do you have any previous experience with this [Attach] particular use case?

Start the game

Questions following the test

- Were the questions shown in a suitable frequency?
- How did you find the feedback with the rectangle?
  - What did the green rectangle mean?
  - What did the red rectangle mean?
  - What did the green rectangle mean when you clicked the red button?
- Did you feel you had enough time to read the text?
- Did you feel that you learned something new?
- Would you prefer to have more/less information in the game?
  - More parameters?

  - Include troubleshooting?
- What do the points mean to you? Did you look at noticed the points? (some other way of earning points?)
- What do the stars mean to you?
- Can you come up with an alternative way of interacting with the signals? Alternative game?

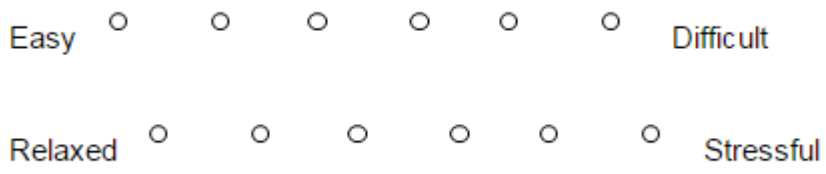

Figure E.1: Self assessment questionnaire