Proposing Game Concepts and Design Recommendations for Minority Language Learning: Karelian Language

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***Abstract*—Revitalizing endangered minority languages is important. Learning games and gamified application could provide potential ways to support learning of minority languages and their dialects. We present the findings from evaluations made for the popular learning games and Karelian language learning games. Based on the results, new concepts and design recommendations are presented for minority language learning game development, especially in Karelian language context.**

I. INTRODUCTION

Gamification and serious games are used in multiple different areas, education being one of them. In gamification, the game mechanics are used in a context that is not a game. [1] Game mechanics provide different benefits to the user's activity [2]. For instance, the use of badges increases the activity of the users on social platforms [3] where self-determination theory is used to explain the motivational aspects [2][4]. Some game elements like competitiveness can be seen as controversial topic as some users get motivated from it and some get put down [5], making it important to characterize the players into different categories based on their player profile [6]. Educational games tend to have one clear purpose like teaching vocabulary [5] but gamified learning applications usually are formed in a way that they are supporting the user throughout the language learning process [7]. In many cases the educational games are used by a teacher in a controlled environment [5]. Having someone like a teacher to give feedback can be valuable as in some cases the games do not give enough feedback or the feedback is missed by the user [8]. The feedback given to the users should also be done in a way that it has a clear purpose. [3]

There are plenty of games available for digital-based language learning and their levels vary from simple hangman type games [9] to more complex games like virtual worlds and AI-based training tools [10], [11]. A need for different kind of educational games for minority languages with different levels of language skills is important. In small areas, minority languages can be in a weak state if parents do not want to teach their children the native language [12]. In larger heritage languages areas can have active communities with social interactions [13]. Ward [14] discusses the challenging aspects of language learning in minority languages as many of them have different dialects formed. For instance, in Karelian language, it is important to design the same game with all its dialects [15]: Olonets Karelian (Livvi) and Karelian Proper (North: Viena and South: Suvi) as implemented, for instance, in a board game called *Karjailini kylä – Karjalane kylä – Karjalaine hieru* [16]. The Karelian language is the closest linguistic relative to Finnish and it is spoken in Finland and Russia, in the Republic of Karelia. Karelian is classified as a minority and endangered language. [17] There exists a few mobile games for learning Karelian language and especially its Viena Karelian dialect [18], [19], [21]. *Learn Viena Karelian* [18] is a web-based game, while *Vienankarjalan Hirsipuu* (hangman) game [20] and Kielimestari [21] application are developed for Android OS platform. Kielimestari [21] gamified application is targeted for learning minority languages: Karelian, Swedish and Northern Sami. There exists also another hangman type web-based game called Riputandupačas [9], which is implemented for learning Livvi Karelian.

The chapter 2 introduces the prior research relating to language learning and educational games. The chapter 3 presents the findings from the evaluations of popular language learning games and existing Karelian language learning games. The chapter 4 presents new concepts and design recommendations for minority language learning game development. Finally, the paper is discussed and concluded.

II. RELATED RESEARCH

Even though prior literature on educational games for language learning is extensive the minority languages aspects has not taken widely enough into account. This chapter presents different types of language learning games and then look into the game mechanics and discuss what effects they might have on the players' experience and learning.

A. Language learning and educational games

Little [22] studied the families, that had second language learning as heritage language, and interviewed on their language learning application usage. The three most frequently used applications in these families were MindSnacks, Memrise and Duolingo. It was noticed that most applications for

language learning were designed and made for new language learners or to people that already were proficient with the language. [22] The VocabTrainerA1 game was designed for a group of people. It first had a story for players to read and then they were given roles in the story (a murder mystery). Communication and working as a team with the new language they were trying to learn was essential. First there was a learning session where essential words that would be used in the game, like body parts, were taught to the players. [10]

The PHONE words game [23] has various types of mini games built in for users to play. Most of the games were built and meant for two players. Games such as tic-tac-toe, hangman and tug of war were some of the mini games were turned into a small competition between the two players. In the tug of war players were asked vocabulary questions and each time they answered correctly their avatar in tug of war pulled the rope a little more, eventually winning when getting more answers correct than the opponent. [23]

Acquah and Katz [5] have investigated language learning games and found out different types of games used by the researchers. The most intensive and biggest is a simulation game called Second World, where players could create their own avatar and interact with other people in a virtual world. This required a third party, a teacher, to create a learning situation in the virtual world for the players to act a part in. A few different sites with mini games were presented. On the website eslgamesworld.com they brought up crossword puzzle, matching game, word search, spelling game, a few different types of board games and a sea battling game. Other murder mystery narrative game Whodunit was also used. [5]

Advances in mobile technology and especially Mobile-Assisted Language Learning (MALL) applications are beneficial in vocabulary enhancement and reading comprehension [23]. The same beneficial effects can be seen in all the Digital Game-Based Learning (DGBL) areas. For instance, vocabulary can be studied using games for L2 (second language) learning, especially difficult words are handled well by people that have background in playing commercial-off-the-shelf games [24].

Acquah and Katz [5] investigated how the educational games were used and if they were used in a classroom or at home. Out of the selected 26 papers, 46% of the games were used in a classroom by a teacher, 23% in a classroom scenario but without teacher's interference and the rest were mostly at home, some hybrid forms between the three were found though. 78% of these papers reported positive effects from using their educational games and the rest were either mixed or not statistically significant, but straight up negative studies were not found. [5] Martí-Parreño et al. [25] studied teachers' opinions about gamification in educational context and found out that approximately 62% used gamification in their classroom environments and only around 11% regularly.

B. Aspects to consider in language learning game design

Acquah and Katz [5] found out that when learning vocabulary, the game should be easy, but in different aspects the games need to be more challenging. Having different degrees of difficulty depending on what the game seems beneficial. Social aspect also is something that motivated the players well, having someone to talk to about the game or the learning process helps. Instant feedback was also something that the players liked in the games as long as the feedback was well constructed. One of the most controversial aspects was competitiveness as it was found out to be beneficial in some cases and in some cases, it made the players feel bad if they scored worse than the others on a game. [5]

The players need to understand the rules of the game in their own native language before the games begun, otherwise they will just be lost trying to understand the mechanics and rules of the game without actually learning. Also, the game needs to be interesting for the players. [26]

Rosell-Aguilar [8] constructed an interview for users of the Busuu application, which is used for language learning. The aim was to investigate how users feel about the application, how they use it and what else the users do to learn a language. Users liked the most vocabulary, hearing comprehension and some grammar sections of the application. The least liked ones were writing, grammar and correcting people's writing. Getting feedback was preferred a lot by users, although over 6% did not feel receiving any kind of feedback from the application. [8] Children aged 10-11 years mostly instantly skipped the long feedback [28]. Instead, they just tried to do the task again after failing the first time.

Kolb [29] presents different types of game mechanics and how they should best be implemented in a gamified application. A list of 11 rules with explanations is provided [29]. Four of the eleven rules are about the quests or the missions that the gamified application offers for the users. The quests should be short, users should be able to create their own quests and decide which quests they want to do, so that the system is not forcing something upon them. A lot of experience points should be given to the users, instead of giving players one to three crystals for every task, instead they should be given one to hundred. Anonymity is one thing that should be possible on the leaderboard. In addition, surprises for users, rewarding excellent performance and showing failure as a new way to learn as mentioned. [29] Hanus and Fox [30] have also studied the effect of having a leaderboard and how it would affect the users. They found out that having an anonymous option in the ranking system would make users feel better about themselves as they would not be as heavily judged by their peers. Also, the effects of gamification in their gamified group made people that were previously less motivated more motivated, but the people who were more motivated earlier had a decrease in their motivation levels due to the fact of having gamified application present in the educational environment. Game-based learning and educational games can have decreasing motivational aspects when the game ends and the learning process comes to a stop, but gamified language learning processes usually are more broad and that is why they can help the language learner throughout the process [7].

C. Minority language learning

Rodina et al. [13] studied language learning of heritage language in Israel, Germany, Norway, Latvia and England. Russian was used by the families living in these countries. The study did not show any correlation between the language structure of the five countries that the participants were living in and Russian, but only the effect of hearing and using the heritage language outside and inside the residence was deemed to be profitable. [13]

Ward [14] found out that heritage and endangered language teaching has many challenges, the biggest of them being limited resources. Out of these limited resources the biggest factors are limited monetary capital and not enough technological capabilities to make the tools to teach these languages into a digital form. The people learning endangered languages often are different in nature to the normal L2 learners as their age and level of motivation are not the same. Smaller language groups can also be difficult in the nature because the dialects of the language make things difficult. [14] Polinsky and Scontras [31] discuss how difficult the smaller dialects can prove to be when the original language of the country has mixed up with the new country that the people live in and that is how some of the people living there can talk way different dialect compared to the original one their parents talked in the country they were living in. In these cases, it can be hard to determine how correct their grammatical rules and vocabulary are.

Little [22] studied how heritage language families let their kids use language learning games and on which platform most of these games were. The studies suggested that the primary source of studying for the kids still was books, and the mobile and web applications were used equally as much. Kids were more excited about the smart device applications compared to the web ones. [22] Chiaráin and Chasaide [32] studied AI-based bot that was used to teach three different dialects of Irish to 16-year old students. The voice recognition capabilities, the speech capabilities were said to be good by the participants and the bot also formed a personalized profile for each of the students so the replies more fitting. [32]

Ward et al. [33] studied a mobile application called Word Bricks and more specifically the transformation process of the application into Irish from English. The application was a gamified application. The differences between English and Irish were not recognized as hinderance when making the transformation and kids aged 8-11 were enjoying the usage. The teachers were also giving positive comments about how well it is suitable for teaching Irish. [33]

III. Evaluation Study

This chapter presents the research process and methods how different games have been evaluated (Fig. 1). We studied prior research iteratively during the game evaluation. When benchmarking the existing learning games we focused investigating the five popular learning games [34], [35], [36], [37], [38] in more detail. After this, cognitive walkthrough [39] and an heuristic evaluations were conducted for nine Karelian language learning games found from Google Play [20], [21] or web [40]. In this study, we had only one evaluator, who has not involved in developing any of these games but has educated in the field of human-computer interaction and has long-term player experience with different types of games. The heuristic evaluation was conducted by using the heuristics presented by Fitchat and Jordaan [41]. This set was selected, because they are designed for evaluating the user experience of serious games [41].

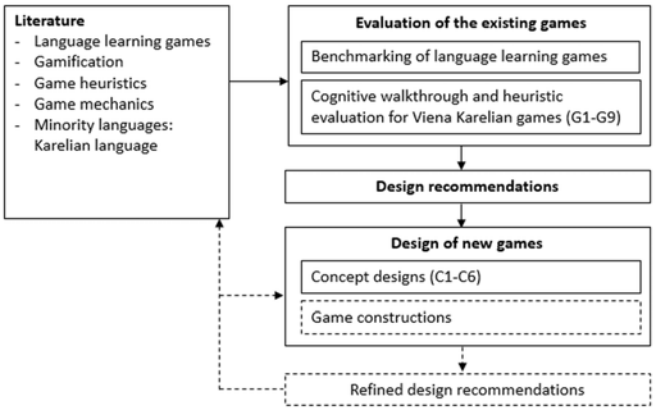

Fig. 1. The study process and methods. The content illustrated by dashed lines is not reported in this paper

A. Benchmarking for popular learning games

The most popular language learning applications found on Google Play were screened. Duolingo, HelloTalk and Drops were some of the applications that were on the top 10 list when searching for "language learning games". The Flashcards Maker and Ekapeli Alku applications were benchmarked because they represent some of the smaller player-based games. When studying the applications, the purpose, primary users, game mechanics and learning purpose were the focus of the benchmarking. The aim was to get a better look at the game mechanics and to identify aspects that should be taken into account when designing new game ideas.

In *Duolingo* [34] many interesting gamified elements were recognized and observed, such as weekly streak, daily goal, lives, levels and progress tracking with levels. Other game mechanics that could be found in the game were speech recognition tools and speech comprehension, notifications popping up and multiple form of visual elements for feedback. Duolingo did not have Karelian as an option for language, but interestingly few other languages like High Valyrian and Klingon that are languages from TV-shows were found. In Duolingo a 5, 10, 15- or 20-minute daily exercising periods could be chosen depending how quickly the user wanted to learn the new language. When starting at the basic level the possibility to skip ahead required a test on the on the previous stuff, in a way where the user's skill level was confirmed.

HelloTalk [35] was not available in Karelian either despite the 150+ languages included in the application, interestingly High Valyrian and Klingon were found on the list once more. The main concept of HelloTalk differentiates from the usual bunch of serious games as this was more of a social application made for connecting different language learning people. The application has a user profile as the center of the

design and users can either communicate with other people or update their own profile with status updates. These status updates then can be corrected by the native people of the language that the user is trying to learn. The point of correcting someone is that the user gets a point to their badge in their profile, which makes them more interesting to the others. The age group for this application would be up from teenager as it lacks any playful elements.

Drops [36] was interesting vocabulary learning game, not only in the sense of its visually pleasing aspects, but also since it had minimalistic text elements in the mini games. The simplicity of the pictures and then combining them with words for meaning made it an application interesting for Viena Karelian and how easily it could be changed for new language. There were no scary grammatical rules, which makes this game good for kids. Time when playing was also something that was noticeable, users only had five minutes to complete the language level and there were 17 food related words in the first level in the Finnish language that the game was observed in. The words were all read by a female voice every time they appeared on the screen or user got a correct answer, making it repetitive and after a new word was presented, the application might have suddenly went back to already learned words which was a good feature. Words also had to be spelled at some points with innovative methods such as drawing on a lock-screen like structure of 3x3 grid of letters inside balls.

When searching for the language learning games on Google Play, a different kind of application was introduced with the name of Flashcards Maker [37]. Since it was brand new application and possibly could provide some new techniques or elements for serious game developing, it was selected and tested. Karelian was not on the list of languages to learn, but Sami language was. The words in Sami were not included though and the user had to manually input the words that they wanted to learn. The saving factor was the words could be put in as larger excel tables, as typing each word individually would be a painful experience as was observed. Possibility to add a picture to the flashcard was in the application and it is highly recommended for new language learners as it helps them to associate the translated word with the subject. Using the application by teachers or for some specific vocabulary studying by individuals are the main purposes of this application.

When searching for ”Karjalan kieli” (Karelian language) a game called Ekapeli Alku [38] was found. It is a language learning game for Finnish language and the main age group of the users is 6-8 years. The quality and variety of game mechanics was instantly observed as users had to create a profile with a character, even some basic added customizability like colour of the clothes and skin colour were implemented. Players start from edge of an island in a 3D world and they have a path laid out in front of them where stars and question marks represent the levels. Players have options to choose from when reaching the star, the games have reading or listening exercises where the learning goes from the most basic sounds of alphabet pronunciation to sentences that are read aloud by a native speaker. Players are rewarded with purple diamonds for their progress in the game. The way players need to click all kinds of things on the screen it can be a bit tedious for people that have not played many games on smart devices.

B. *Evaluation for Karelian language learning games*

This section presents findings from the evaluation conducted by using cognitive walkthrough approach for nine Karelian language games and gamified applications.

1) G1: Grosswords (Sanaristikko [40]) has three different versions available of it. The first version of it has words in Viena Karelian presented at the top and the crossword puzzle has pictures in front of each line (Fig. 2, G1). The instructions tell the player in Finnish to choose a word from the top row and to place it (drag and drop interaction) in the crossword based on the correct image. The images used are clear pictures and leave no room for guessing as they all are from different themes. The game lets users to try as many times as they want without any penalty until the crossword is filled. The second and third version of the game [40] are different from the first one as in them only the images with the empty letter boxes are presented. If the word or even one letter is wrong, the whole word disappears from the box and a user needs to try again. The first version is the easiest to approach for a beginner compared to the two others as both of them require either knowledge of the language or use of a translator application. The game is suitable for learners from all the age groups (except illiterate users) as players are not relying on things like reflexes, spotting small details or playing against a time. Presenting the words, that were used in the crosswords, to the user could have been a good addition to the second and third version. This would of course in a sense defeat the purpose of the crossword game depending how many available words and picture combinations are made for the game. Another good way to fix the situation is to give users help when trying to solve the words, in a form of single letters or showing which letters were wrong when guessing, that way the user would not have to write the whole word each time with the new guess. This would be useful especially in the longer words. On mobile version the pictures could end up being small and an elder persons might have harder time recognizing them.

2) G2: Word soup (Etsi sanat [40]) game also had two versions which are different in terms of execution. The first version has fruits as the theme and the instructions are to choose an image, then to find the word in the box of letters by clicking the first and then the last letter of the word. The images used are clear and big enough for users to click on them. This version does not teach the words to the user in advance, so they need to have language knowledge prior to playing. Guessing the words is one possibility, but that is more time consuming in the case where the words are all scrambled. Using translator, a dictionary or having knowledge of Finnish language are helpful tools in this game, but these things are not something to rely on when designing a game for language learning. Using the web version also seemed to have a feature where user had to drag the mouse on the letters of the word, otherwise the guess would be a failure. This could turn into a problem on a trackpad, on a mouse that has high sensitivity or

if the person playing does not have the most accurate eye to hand coordination. The same issue was not existing on a smartphone. In the second version (Etsi sanat – viisi teemaa [40]), users have an option to choose a theme (e.g. animals, family, food, body parts and numbers). The game shows the user all the words that they need to find from the combination of letters (Fig 2, G2). This way users do not need a dictionary or knowledge to play the game, they can just start searching the words. The only problem with this solution is that the translation or meaning of the words that users are looking for are never explained. The theme is known, and the words can be found based on that in some cases, but in educational games this should not be the case. In this version, a player has an option to select a level of difficulty and the order of the words is randomized which enable to play again. In both versions the educational aspect of the game is lacking, in the first version the users do not have the explanation for the image and in the second version the users do not have the explanation for the word they have found. A combination of the versions could be good so that when a user finds the word, an image appears next to the word. In the second version the users could not tell when they are giving the game an input, some visual cue like highlighting the letter they clicked could be in order. This was done well in the first version. Back button should be considered so users could go to the menu as in now refreshing was the only option to go back.

3) G3: Memory game (Muistipeli [40]) is a game where two of the same kind of cards are searched and matched, turning around only two cards each turn. The idea of the game is simple, but three versions of the same game are presented. In the first game the idea is in the simplest form and requires no existing knowledge of the language, making it perfect to be the one to begin with as the cards have pictures and text explaining them (Fig 2, G3). There are four different categories (foods and drinks, body parts, numbers and animals) to choose from and all categories have option to play with 8, 12, 16 or 20 cards on the screen. The only problem with a game like this is that whenever user finds a pair, they probably will not take too much time trying to remember the foreign word as they will just keep playing and trying to find the next pair. In the second version of the game there is a static number of 36 cards on the screen. The instructions are also different as the users are prompted to now match a picture and a word. This version requires previous knowledge of the words used and all of the words used are from the theme body parts. The third version of the game is an extension of the second version by proving practicing task for a player. When a pair is found the users are asked to use that word correctly in a sentence. The users need to know how to bend the words to fit the sentence properly. This can prove to be very difficult but thankfully after few tries a button to skip is given to user. The order of the versions is fitting, and it is almost as if they are different levels of difficulty, the first version being easy to approach by users of all ages the last one actually requiring grammatical skills. In the first version of the game the game is nicely presented compared to the second and the third that have the cards laid out way too close to each other, clicking the wrong card in these cases is possible and it just looks way too cluttered. Having light green text on a white background is also not as clear as having black text on a white background.

4) G4: Picture game (Kuvapeli [40]) is a perfect type of an example of a game that is fit to test vocabulary skill in form of a quiz. The users have an option to choose from four different themes that are numbers, body parts, food and animals. There is also difficulty option for easy or hard and the only difference between these is the words that are showed to the user. If there is a picture of an apple, in the easy mode the words could be translated versions of apple, ice cream and bread. Obviously, it is easier to find the correct word from this set. In the harder difficulty the words had small differences between them. The number of options is always three in this version. The game did not show the correct answer to the user when answering wrong (Fig. 3, G4). How could users expect to learn anything if they will never be corrected and just keep answering wrong until they get it right once. The colour of the correct answer could have been green instead of blue as it is usually associated with correct answer, blue is the same colour as the borders of the answer buttons and the picture.

5) G5: Weekday game (Viikonpäiväpeli [40]) is a similar game to the picture game as it has the same quiz format, although this game has more game mechanics that makes it more pleasurable experience to play. There are three difficulties and instead of changing the way the words are presented and having always only three options, the easy difficulty here has three options, the medium has four and the hard has five options to choose from. The game has a live counter of the score underneath (Fig. 3, G5) and the users are given feedback instantly after the answer is made in a form of a small emoji and a text presented. However, the correct answer is not shown with the feedback, which decreases the educational aspect of the game.

6) G6: Cat commands (Kissa käskyttää [40]) game is more unique compared to the earlier more known games. The game does not have any instructions given to the user on how to play the game. However, the game is quite self-explanatory in a way that the cat has a speech bubble coming out of their mouth and in the bubble, there is a text in Viena Karelian. The cat asks for things and all the possible things that the cat can ask for are spread out on both sides of the cat (Fig. 3, G6). The users have to figure out themselves that the items are needed to drag-and-drop from the side on the cat icon. The cat then shows tongue if the answer is incorrect and the item gets a big red circle with a line crossing it so they cannot choose the same answer. If the users do not understand what the cat wants it is not that bad as there are only eight options to choose from. Whenever a correct answer is guessed the cat whips their head back and smiles, which makes the item that was given disappear from the list. This game has more advanced learners or people who can connect the dots with Finnish in mind as a beginner would have a hard time understanding the words. The idea of having an animal as the center of the game is playful and makes the game fun educational tool for all age groups. Some instructions on how to play the game would be

in order. The cat could tell how to play the game to the user before starting the game. The subtle whip of head or showing tongue depending if the answer is correct or wrong is also something that the users might not see. Therefore, giving feedback in a form of text or sound should be considered.

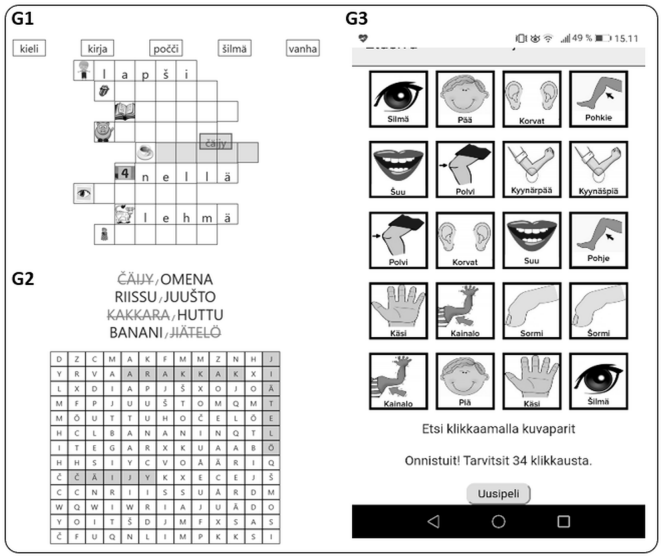

Fig. 2. Examples of Crossword (G1), Word soup (G2) and Memory (G3) games

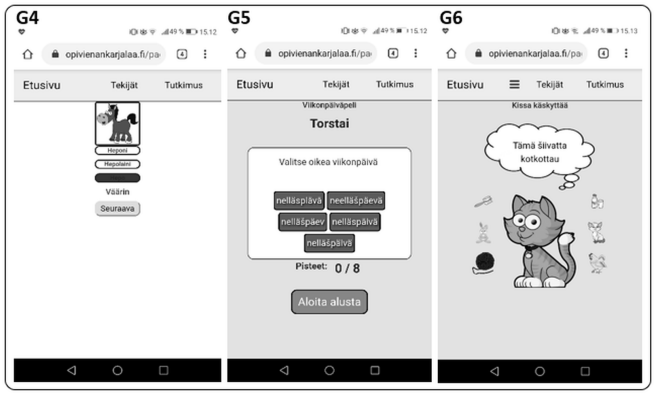

Fig. 3. Examples of Picture (G4), Weekday (G5) and Cat commands (G3) games

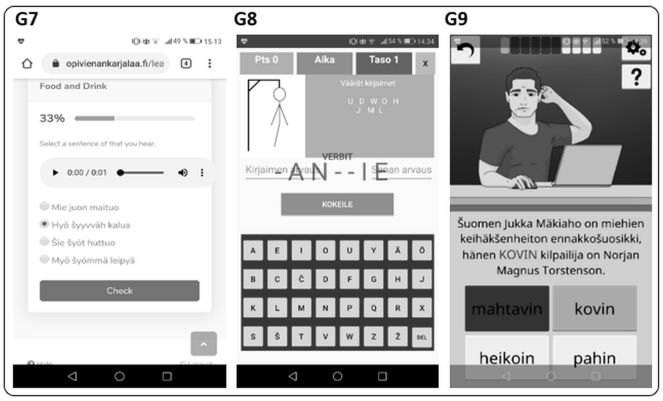

Fig. 4. Example screen captures of Learn Viena Karelian web game (G7), and Viena Karelian Hangman (G5) and Kielimestari (G3) mobile applications

7) G7: Learn Viena Karelian game [40] (Fig. 4, G7) is the only game on the website that has the option to choose the language as English [18], and that already is a clear signal that it is more finished and advanced game than the previous ones. The game has lots of gamified elements such as user profile, achievements, scoreboard and points. If the users want to, they can choose to be on the scoreboard anonymously, which is a great addition for users that want to stay private. The game is nicely streamlined for educational purposes in a way that the users are first given an easy instruction into the word, then the same word needs to be listened to and chosen from four different pictures. If the user chooses the wrong answer, they are given another try and an instant feedback comes in form of a pop-up box from the browser. The listening part is done with a robotic voice and is clear to understand as all the options are not only few letters apart from each other, but they have all different meaning and words used. The themes that the user can choose from are food and drinks, clothing, furniture, seasons of the year, body parts, numbers and dates. There are some parts of the game that could be done better. When writing the translations for the sentences the users need to be exact in their wording and no room for error is left. The sentences and the words in them need to be word to word and in questions the question mark is also something that is needed, without it the user is left with a "wrong answer" pop up, but in normal sentences the dot at the end also makes the game state that the answer is wrong. The lack of keyboard input on the web version when typing the sentences was annoying. A button to skip the sentence or go to the previous one could have been something that would have made the game more enjoyable as now the users can get stuck on a translation task and only possible way to go through it would be getting a translation help from outside or resetting the game completely. Resetting the game would make the user infuriated as their score would be wasted and the progress, they have made would be all for nothing, except of course from educational standpoint. It is obvious from the lack of playfulness that this is just a gamified learning application and the similarities with the more popular applications on the market are apparent from the game mechanics. The game fits for all the age groups (except illiterate), but with the rather dull elements it may not be interested by younger audience. After finishing a task, the users are given a cultural info packet about things related to Viena Karelian which is exciting. After finishing one of the themes the users cannot go and revisit those tasks without resetting the game fully. When looking at the application on a smart device (phone size), some of the aspects could be better designed for ease of use on mobile devices, such as the radio button selection could be turned into bordered boxes with wider gaps.

8) G8: Viena Karelian Hangman mobile game [20] utilizes a common metaphor of a hangman game. To make it more exciting the game has three different modes for the user to choose from. The first mode is the basic game where words start as short as 4 letters and then go up one letter each time the user gets the word correct, if they do not get too many

answers wrong or lose by time limit before that. There is user profile and all the scores are logged and if score is high enough, they are placed on the scoreboard where the top 10 best scores are shown. The second mode of the hangman has one letter given to the user as a hint, but otherwise is the exact same mode as the first one where the user has approximately 4 minutes to finish the word. The third mode is different as it has themes to choose from (seasons and numbers, animals, human, nature, relatives or verbs). There is also no time limit in this mode and the number of letters in the word is completely random. This game is only available on mobile device and on a 5,2 inch screen the game had some usability issues where elements on the screen were stacked on top of each other (Fig. 4, G8), but it was not something that made the game unplayable and it was still easy and fun to try to guess the words. Without prior knowledge of Finnish or Viena Karelian, the game is pretty much unplayable, but with Finnish it could be pretty easily played. Educational value of the game is not as great as the words are not explained in any way, but the entertainment value is great. In these types of complete games, it is hard to say what aspects could be changed to make it better. Some type of hints for the users could be given with the cost of points, like giving letters or giving an opposite of the word, for example, "is not cold" and the word is "hot" or something like that. That could be accessible in one of the game modes especially for new learners.

9) G9: Kielimestari application [21] is the most visually pleasing game out of all the evaluated games made for Karelian language. Even though the graphics are advanced and nice looking, the educational aspect of the game is almost as simple as the Weekday game (G5), where a word is given to a user and s/he needs to select the correct answer from four options. The fact that the word is used in the sentence does not give that much help if the language is not familiar. There are also Swedish and Sami languages available in the game. There is a player character and a user needs to move to a place with the character. There are three different places to go to, the character walks to the place and after that the user needs to select the language depending where they are (on the map of Finland). After selecting the language, the themes are shown in form of pictures, there are medals, dancing, skateboarding, movies, games and sports to choose from in the Karelian language area. It is obvious that the game is still in the making as the same questions come up twice even with 10 questions only presented to the user per theme. What also differentiates this game from others is that there is audio feedback given to the user after each selection, the character in front of a laptop will also show thumbs up if the user makes the correct answer or look a bit sad if the answer is wrong, the feedback after the round of sentences can be a bit hard for the user and not really motivating as the game states for the user: "Argh, did you even try?" The game is suitable for all age groups (except illiterate), but the educational elements of it are mostly suitable for testing knowledge. At least the correct answer is shown to the user even for a brief moment before automatically skipping to the next sentence. A slow reader might miss the correct spelling of the correct answer in this case so making the time just a second or few longer would not hurt the user experience and would give much more to the educational aspect.

C. Heuristic evaluation findings for all nine games

In addition to cognitive walkthrough, we studied games by utilizing the heuristics [41], which take user experience aspects into account. Findings from evaluations are summarized in Table I. We went through each heuristic for each game and checked whether the heuristic was realized or not. If the heuristic was considered, it means that it was realized, and we gave two points. If heuristic was not realized, we gave zero point. Some heuristics were realized partially in some games and those got one point. Realization of heuristic and scoring for games are presented in the Table II.

TABLE I. FINDINGS FROM HEURISTIC EVALUATION

Heuristic	Evaluation findings (G1-G9)
Convenience	Game is available in the internet for browser, playable on mobile and PC. (G1-G7) Game is only available on the Android platform on mobile. (G8, G9)
Enchantment	Game does not have any messages to try to make the player to return to the game, but the players should feel enchanted when playing. (G1-G9)
Effortless learning	The learning is not effortless as vocabulary is the center of the game. (G1) Effortless learning possible as words are given for the user. (G2) Effortless learning is easily possible as the game is quick tempo and requires for users to look at the words. (G3) Learning can be effortless depending on the knowledge of the user. (G4-G8) Effortless learning is possible through the association of the words and sentences. (G9)
Positive encouragement	Players are not motivated in case of failure. (G1-G9)
Possibility to practice	Previous tasks are easily accessible making it easy to practice. (G1-G6) Previous tasks are not easily accessible as it requires a full reset. (G7) Practice of the game is possible, but it is hard due to nature of the game. (G8) Previous mini games are easily accessible. (G9)
Rewards for achievements	Players are rewarded with positive comments when completing the game. (G1-G3) Instant positive feedback for successful answer. (G4-G9)
Use of all senses	Game has some visual elements but no audio to compliment it. (G1-G6, G8) Game has audio elements in some parts. (G7) Continuous audio-visual elements in the game. (G9)
Progress tracking	Progress can be tracked due to the open nature of the game. (G1-G3, G6, G8) No continuous progress tracking in the game. (G4) Players are shown how many they have completed, but not told how many are left. (G5) Progress is well visualized in form of stars. (G7) Inside the mini game the progress is tracked but overall progress is not found. (G9)
Guidance	Game has guidance text, but no additional help in problem situations. (G1, G2, G5, G7, G8) No guidance at all. (G3, G4, G6, G9)
Player centred design	No customizability and the players have a hard time feeling immersed or centered. (G1-G5, G7, G8) No customizability but the character (cat) can lead to kind of immersion. (G6) With the character the players can feel some sort of immersion. (G9)

TABLE II. REALIZATION AND SCORING OF HEURISTICS (YES=1, PARTIALLY=1, NO=0). POINTS ARE SUMMARIZED (SUM) FOR EACH INDIVIDUAL HEURISTIC (H) AND FOR EACH GAME (G)

H	G1	G2	G3	G4	G5	G6	G7	G8	G9	Sum
1	2	2	2	2	2	2	2	1	1	**16**
2	1	1	1	1	1	1	1	1	1	**9**
3	0	2	2	1	1	2	1	1	2	**12**
4	0	0	0	0	0	0	0	0	0	**0**
5	2	2	2	2	2	2	0	1	2	**15**
6	2	2	0	2	2	2	2	2	2	**16**
7	0	0	0	0	0	0	2	0	2	**4**
8	0	1	0	0	1	2	2	2	0	**8**
9	0	0	0	0	0	0	0	0	0	**0**
10	0	0	0	0	0	2	0	0	2	**4**
Sum	**7**	**10**	**7**	**8**	**9**	**13**	**10**	**8**	**12**	

According to analysis, heuristics 1, 3, 5 and 6 were realized the best in the games (Table II). Heuristic 2 realized only in the games partially and the description for that heuristic indicates the reason for that (Table I). The use of notifications to get the player to return to game is so common in the games that are designed for the wider market. As all these games were done in research purpose, the lack of phone or mobile alerts were lacking because of this. Heuristics 4 and 9 were not present in any of the games. None of the games had any positive feedback to the user when failure happened so this heuristic could not be said to be considered in any of the games, possible partition of the heuristic into having minimal negative feedback and having positive motivational text when failing could be discussed. The heuristic 9 was a similar thing where users were told what to do in the beginning, but no additional help was provided to give a deeper explanation as to why things are happening the way they are.

D. Summary of game evaluations

The evaluated games G1-G8 are made for research and teaching purposes [40] and Kielimestari (G9) is its first published version [21]. Therefore, quite many findings from evaluation related to basic usability aspects or visual design. However, it was important to evaluate these games even though they are in their early design phase or they are developed as research prototypes. There are not many digital games available for learning and practicing Karelian language. Therefore, it is important to report these findings and try to find out the best solutions for proving enjoyable learning experiences for beginners and advanced learners. Especially when trying to revitalize minority languages, it is important to provided gamified solutions for all age groups.

When comparing G1 to G6 learning games to the popular Google Play language learning applications the differences are obvious. These games for learning Viena Karelian are lacking the more advanced game mechanics such as audio input or output for speech recognition or speech comprehension. Revitalizing Karelian language would require native audio examples. In addition, these game examples lack the basic usability and user experience elements such as “help” button to give the user guidance when they feel like they are stuck or do not know what to do. Other more advanced gamifying elements such as badges or level progress are also missing. The fact that all of these games represent different variations of the same concept in a form of multiple versions, such as three versions of memory game, tell that they could be combined into one better version. These versions are clearly examples, which could be utilized when developed on bigger game platform.

One possibility when combining all of them into a bigger game could be a solution where the cat (or some other animal: bear, fox, wolf, rabbit) is the guide or the character which can lead a user into the different games. First the cat would greet the user and ask their name, user profile with character image could be made, then the journey to the games could begin. The evaluated games, especially G1-G8 go well together as they share the common themes, so making them into a streamlined journey where the player would gain experience after each game. At the end after finishing all the games, the user would be tested with the Weekday game and Picture game, to see if they learned anything and if they pass them, they would have finished the game. Many of the games had random elements so playing the games each time would be different, which makes it perfect for going back and trying to get more score in the singular games, such as memory game. As most of the games had levels of difficulty built in them, they can have added difficulty when replaying.

IV. GAME CONCEPTS AND DESIGN RECOMMENDATIONS

This chapter present six game concepts (Fig. 5) and 22 design recommendations derived from the evaluations of games (G1-G9). When starting to conceptualize, the idea of user group, game mechanics and heuristics were considered. The concepts are summarized in Table III where the platform, idea of the game, characters, starting position, goal, context, number of players, user groups and game mechanics are briefly presented. The process of visualizing the images was done with rapid sketching and therefore, all aspects relating to usability and user experience are not visualized in concepts.

A. Game concepts

1) C1: Threat in Karelia is a concept where a map of the Republic of Karelia is used, and different types of threats were appearing. The Fig 5 shows an example case, where the threat of a storm (e.g. thrombus or hurricane) is approaching the character (C1, left) and where it is diminished through questions and different kind of tasks (C1, right). Examples of threats can be realistic or totally fantastic ones. It is important to visualize threats in a children friendly manner so that it would be a possible to use a concept as a learning game for children. Different kind of linguistic tasks then would follow, and correct answers would make the threat go away and keep the language alive in the area. The idea for the concept comes mainly from the fact that minority languages are endangered and saving them by using them would revitalize and strengthen them. Learning would be effortless and fun with players all senses used. The concept could be possible to implemented as a web or mobile game.

2) C2: Karelian or Finnish? is a concept where vocabulary words with pictures associated to them appear on mobile device and a player could just swipe left, right or up depending on the word (Fig. 5, C2). This concept could be one

of those smaller types of minigames in one of the larger games, the idea would also work on its own. An idea in this type of easy learning and practicing game came from the fact that Finnish and Karelian are very closed, especially in Viena Karelian dialect there exist several similar words than in Finnish. Likewise, some words can be similar, but the meaning is different. In this type of concept, a player can learn and practise which are the same in both and which different.

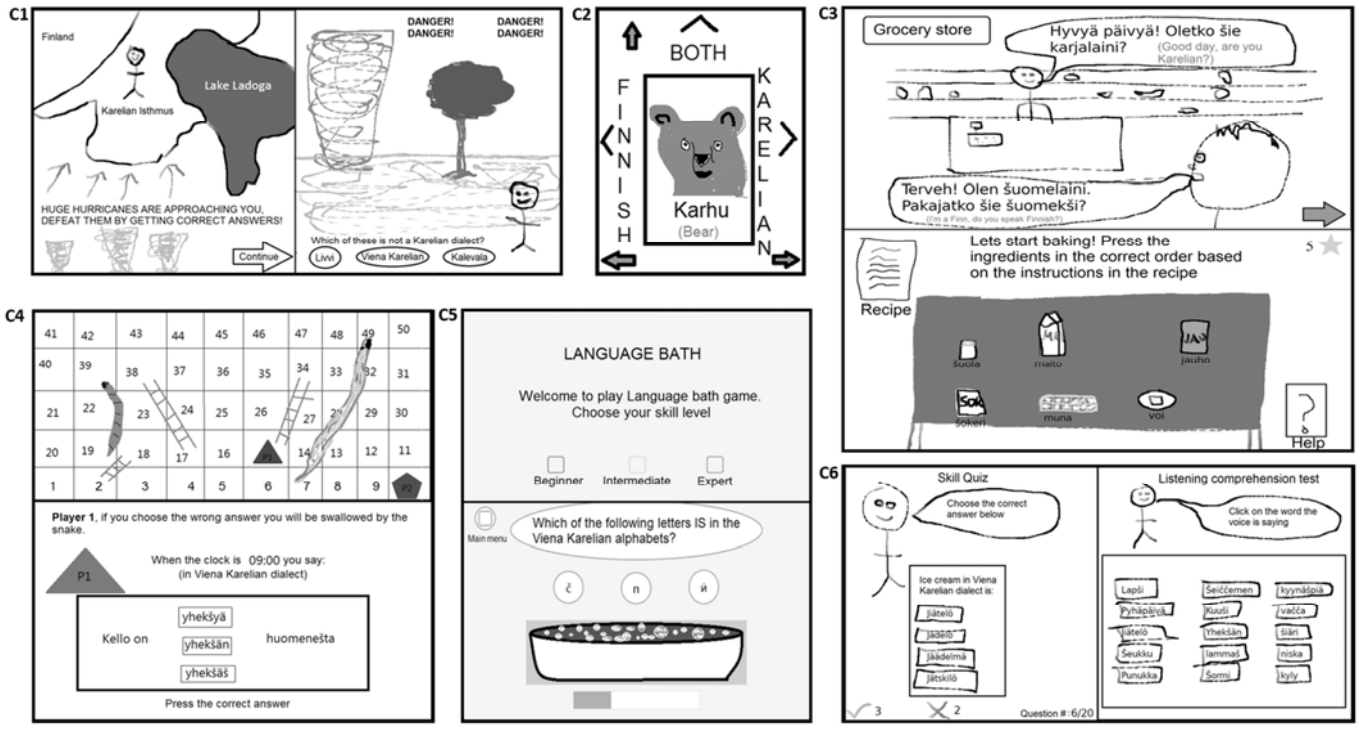

Fig. 5. Concepts: C1) Threat in Karelia, C2) Karelian or Finnish? C3) Karelian pies, C4) Ladder to Viena Karelian, C5) Language bath, and C6) Test and Practice Viena Karelian

TABLE III. SUMMARIZATION OF THE GAME CONCEPTS

Concept	C1	C2	C3	C4	C5	C6
Platform	PC, smart device	Mobile	PC, smart device, card, board	PC, smart device, board	PC, smart device	PC, smart device
Idea	Defending Karelian region by completing language learning tasks	Various words with pictures shown to player, swipe direction of the language	Story game with different kind of real-life situations, Karelian language used	Throwing dice to run to the end of the game, language tasks to prevent going back or moving forward	Teaching language via gamified elements and visual effects where the bathtub is the "teacher"	Gamified elements with some cultural aspects like game guide to help and support the player
Characters	Player	Player	Player, Shopkeeper, bus driver	Players as buttons	Player	Player
Starting	Karelian cultured presented then suddenly threat appears	Different themes for, word and picture appear on the screen	Player character is home and has guests arriving, wants to offer pies	Square 1, player rolls dice and moves	Choosing level and then starting to learn via tasks	Starting quiz to test the knowledge of the player
Goal	Teaching Karelian culture and language in a fun way by protecting earth	Teaching vocabulary by theme in a simple manner, to complete all themes fully	Go to town and buy materials to make Karelian pies all in Viena Karelian	Reaching square 50 before another player does	Going through all the language learning tasks available	Progressing through the game to learn broadly about Karelian language
Context	Modern day Karelian region with unnatural elements	Themes of food, dates, animals, basic sayings	Karelian region in a time without smartphones	Can be adapted according to different themes	Can be adapted according to different themes	Can be adapted according to different themes
Players	1	1	1 / 2+	2 / 2+	1	1
User group	All	All	12+ years for solo, All for multi	All	All	All
Game mechanics	Levels, stars, badges, 3D map, character	Themes, progress tracking	Character, levels, virtual scenarios	Minigames, task success tracking	Levels, progress tracking, feedback, help	Audio recordings, progress tracking, levels, feedback, help

3) C3: Karelian pies. is a concept where player creates their own character and then they need to go to town/village to buy ingredients for the recipe of Karelian pies. The main way of teaching things in the game would be through conversation in the shop with the seller (Fig. 5, C3: above) and with different kinds of people while in the process of making the Karelian pies at home (Fig. 5, C3: below). The game is fit for all age groups and the process of making the actual food does not require any knowledge on how to make them. The possibility to form this game into a board game where all the story options are on cards and there can be two players, one acting as the shopkeeper and other one acting as the player. In the baking phase of the game the other player can guide the player with the instructions as they place the ingredient cards on the table in the correct order. When used in live version the conversational elements and pronunciation are more highlighted. This type of game would also teach about the food culture.

4) C4: Ladder to Viena Karelian concept comes from the old snakes and ladders type of game where two players go head to head on a board, throwing dice until other one gets to the goal. Ladders on the way let players get up multiple rows or snakes can "eat" the player to make them fall down several ranks (Fig. 5, C4: above). Whenever a player lands on a ladder or a snake they are given a task, a word, a sentence or something else to translate or change one word to make it correct (Fig. 5. C4: below). The fact that another player is needed makes it easier to be played on a browser as there it can be player from tablet, smartphone, laptop or PC. This type of concept could be visualized also by using culture specific elements, for instance, ladders and snakes could be replaced with issues relating to nature, animals or hunting. For instance, a player could pick berries or mushrooms and then avoid facing bears.

5) C5: Language bath is a concept where different kinds of language related questions pop up from the bathtub. The game starts from the most basic form of letters and is in a form of quiz, trying to teach the difference between Finnish language and Viena Karelian (Fig. 5, C5: below). The users are first prompted to select their skill level and depending on the level the questions will be harder (Fig. 5, C5: above). The progression is done with levels and the possibility to advance to a harder level requires completing the easier ones first with the option to skip straight to the harder ones in case harder ones are wanted to try. It would be easy to create variations from this type of concept. For instance, the element from where the words pop up could be visualized relating to contexts what themes player is learning. The bathtub could be used when practicing words or sentences relating to washing. Likewise, an iron pot could be used when learning words of cooking. Changing the visual elements according the themes or in different levels of difficulty could increase players' interest and make the game to be more entertaining and fun.

6) C6: Test and Practice Viena Karelian is a concept where users skills could be tested at the beginning of the gameplay, and then series of vocabulary quizzes would be presented to the player. The game would have audio files that complement the learning. The Fig. 5 shows an example, where is a quiz to test the knowledge of the user with four answers to choose from, counters of correct and wrong answers at the bottom (Fig. 5, C6: left). In the example of testing listening skills (Fig. 5, C6: right) a player clicks the answers that are read aloud by native Karelian speaker. One idea in this type of concept is that the player can learn and test own progress easily with the same application. It is easy to increase a level of difficulty by adding variations of themes and sentence examples.

B. Design recommendations

The language learning game for minority learning should be made to be available for everyone easily. The easiest way for this, is to have the game available on the internet instead of having it as a board game sold offline. The game should not either be only found as an application for smartphones as it might limit some user groups from reaching it. It is important to provide several ways to access to the different games.

Designing the game for multiple languages can be hard depending on the level of the game and if cultural context is present, the difficulty increases plentiful. Cultural context is important when designing the game, because it gives players added motivation to learn the language. Using songs, folk lore or history when presenting the culture gives the players something to look at and listen and refer to when learning the vocabulary and pronunciation.

Feedback and achievements are very important in the light of motivation. Keeping the player's motivation up throughout the playing process is important and using badges, stars and positive feedback are one of the easiest implementations for this in game. There is no such thing as too much of these if they have clear intent and are correctly implemented. One example of a wrong implementation would be if the player needs to click and acknowledge each star after each answer. Correct way for this is to just flash the star for the user and then have it in the corner of the game area to remind them that they are doing well.

Based on the findings of this study the following design recommendations are proposed:

Player aspects

1) Pay attention to the age of the user group, if the game is for children, adults or everyone. In minority language context, it is important to develop games for all age groups (e.g. C1-C6).
2) Aim to motivate a player as much as possible with achievements, badges and instant feedback [3]. Create games the way that they increase motivation to learn and minority languages.
3) Aim to have some form of social element in the game, either by increasing the player count, by adding a scoreboard or sharing results. (as a limit in [41]) One option is to provide a possibility to have conversation with other minority language speakers.
4) Aim to have some type of player character so the player can feel more immersed, preferably unisex

model [41]. One option is to create characters that relate to culture and history of minority language.
5) Involve citizens of minority language users (new learners, advanced and proficient) into design and evaluation processes.

Learning aspects

6) Pay attention to what is the learning purpose of the game, if it is meant to teach vocabulary, pronunciation, grammar, culture or perhaps all of them. (e.g. G3, G6, G9 and C3).
7) Pay attention to adaptability for other minority languages or different dialects of the same minority language, like three different dialects of Karelian language. [33] Finding a good game solution for one minority language and adapt it to other minority languages could help the challenges with the limited resource, monetary and technological issues [14].
8) Aim to have repetition and reappearance of the words when learning simple things like vocabulary to test and assure that the words are fully learned. One option is to provide variations of games, for instance, using crosswords, word soup and different selection games (e.g. G1-G9 and C1-C6).
9) Use themes for helping a user to perceive the vocabulary into one group to simplify learning. (e.g. G1-4, G7-G9 and C1-C6)
10) Avoid scenarios where the game asks too much too quickly from the user, such as after learning a word they are required to use that in a sentence (Example of the third version of G3). Ensure that vocabulary and grammar are learned well before asking a player to use them. Another solution could be that the game helps a user to form the correct sentence or grammar tasks could be showed only when a player has reached the certain game level.
11) Aim to have the game in a linear manner (as in [34]).
12) Aim to let a user has access to already learned parts of the game, so that they can test their learned skills and to iterate words.
13) Involve native speakers and teachers into design and development process of minority language learning games.

Platform aspects

14) Pay attention to the platform for the game, if it is mobile application, on the web or possibly a board game, for example, children were more excited about mobile applications. [22] In minority language context, it is important to provide several ways to play learning games, because people may not have the same technical resources to access the games. Also, families could play board game together and thus share to knowledge of minority language between family members.
15) Try to find digital platforms for games to bet used by minority language communities from different locations (e.g. from different country or dialect areas)
16) Pay attention to the usability aspects on different platforms when designing multiplatform games on the web, for example the size of the pictures should be scaled properly. (Was found as a problem in G1 & G4)

Design aspects (usability & user experience)

17) Use clear pictures where a user can easily distinguish one thing from another, for example separating sugar from salt.
18) Use audio-visual elements to help a user to learn vocabulary, for example audio clip associated to a word. [32]
19) Avoid too quick elements in the game, for example feedback or answer should not just disappear after X amount of time. (Found as issues in G5, G6)
20) Create several variations of the same concept and evaluate their weaknesses and strengths.
21) Develop clear instructions on how the game work and present them to a user before playing and add extra guidance when the user is stuck. [26]
22) Avoid too complicated games that require excessive learning time of the game, the users should get accustomed to the game quickly and easily. [41]

V. DISCUSSION

This paper presents findings from the evaluations conducted for popular language learning games and especially for games developed for Karelian language, which has a status of endangered minority language [17]. During the evaluation several usability and user experience issues were found because these games have developed for research purposes [40] or they are in their early stage [18][19][20][21]. However, we regarded sharing these findings as important in order to rouse discussion and interests to a need for developing digital solutions, for instance, games or gamified applications for learning and maintaining, and thus revitalizing minority languages. Taking into account limits of recourses, monetary capitals and technological capabilities [14], ideal is to find solutions that could be applied for several minority languages. We acknowledge that our game concepts and design recommendations require more studies and evaluations. Even though, there exist several guidelines or heuristics for game developed, we noticed that there is a lack of guidelines targeted especially for game development in minority language learning context.

VI. CONCLUSION

This paper presents the evaluation findings on language learning games, especially games targeted for minority languages, especially for Karelian language. Based on finding we present new game concepts and propose recommendations for minority language learning game design. These are simplistic guidelines that can help developers in the process of creating new games for minority language learning. During the study we were not able to conduct face-to-face user studies for evaluating game concepts and recommendations because of the covid-19 situation. In the future work, we need to develop concepts and constructions for user evaluation. However, we

regarded sharing these findings as important, because endangered minority languages need designers and developers help and contribution. If we can get academy or industry to find digital solutions for revitalizing some minority language, the solution may could be adapted to several or all minority languages.

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