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## PHASES OF GAMIFYING CROATIAN WEB DICTIONARIES (THE EXAMPLE OF MREŽNIK)

### Abstract

*This paper focuses on the phases of gamifying Mrežnik. The gamification process was conducted at the Institute of Croatian Language and Linguistics on the project Croatian Web-Dictionary – Mrežnik. The games can help players in learning specific language and dictionary contents. Mrežnik consists of three modules: the module for adult native speakers of Croatian with 10,000 entries, the module for schoolchildren with 3,000 entries, and the module for non-native speakers with 1,000 entries. Some games based on the dictionary content for all three models were developed, and some are still in the development phase. A conceptual framework for gamification was created in parallel to creating these games and includes planning, developing, testing, and implementing the games within the dictionary. The first step was identifying game types and gamification elements present in dictionaries and other lexicographic publications. Before creating dictionary games for the Mrežnik project, the types of educational games and gamification elements used on websites of lexicographic publications were identified (183 web dictionaries and 76 encyclopedias were analyzed). After identifying all possible game types for learning many different types of dictionary content, the next step involved the design and later development of the first versions of dictionary games which contain basic gamification elements such as scoring, leaderboards, levels, time limits, and badges. The next step involved game testing, which was done with two groups of foreign students learning Croatian. The results of the conducted research showed that games can help students learn Croatian as a foreign (other) language. The games for children were presented to groups of elementary school students visiting the Institute of Croatian Language and Linguistics. Based on users' feedback, the games were later modified. The last step involves publishing games, promoting them, and monitoring user satisfaction.*

**Keywords:** conceptual framework, game development, game-based learning, gamification, web dictionary

### Introduction

Gamification is a process in which we take elements from games and implement them in situations that are considered non-game-like by nature (Merriam-Webster, 2019; Cambridge English Dictionary, 2019). Elements implemented from games are called gamification elements, and they can include any part of the game such as scoring, levels, leaderboards, rewards, social components, etc. (Ashaari et al., 2016: 870). Gamification is usually, but not necessarily, implemented through technology (e.g. when a teacher plays an educational game with the students on a school board). Gamification elements can be used for mundane courses and jobs (e.g., a system automatically scoring a worker based on how many items he has sold to customers). Gamification is used in many areas such as education, sale, and fitness. Many learning applications such as CodinGame<sup>1</sup> for learning computer languages and Duolingo<sup>2</sup> for

<sup>1</sup> <https://www.codingame.com/> (26. 12. 2021.)

<sup>2</sup> <https://www.duolingo.com/> (26. 12. 2021.)

foreign language learning, use games (mostly quizzes) and gamification elements such as scoring, leaderboards, badges, and skill trees. Gamification can also be applied through video games. The process of learning through video games is called Game-Based Learning. Educational games are games primarily made to educate the player, but accidental learning can occur through playing games that were made for entertaining purposes (Yip, 2007). Video games for educational purposes can be created for learning materials such as books which also include a dictionary. So educational games based on dictionaries can be created. Technology for creating games is developing rapidly and now there are many web services such as H5P<sup>3</sup>, Quizlet<sup>4</sup>, EclipseCrossword<sup>5</sup>, and free game codes with no copyright restrictions available on sites like CodePen<sup>6</sup> and GitHub<sup>7</sup> for creating educational games.

This paper describes phases of gamification of Croatian born-digital dictionaries. Examples from *Mrežnik* illustrate these phases. *Mrežnik* is a born-digital dictionary created at the Institute of Croatian Language and Linguistics within the research project *Croatian Web-Dictionary – Mrežnik* financed by the Croatian Science Foundation. The gamification of born-digital dictionaries involves developing, testing, and implementing games within the dictionary. The reason for this analysis is that a lot of research on using games for learning purposes has been conducted, but it does not focus on gamifying dictionary content and testing it for learning purposes. The phases of gamifying the Croatian web dictionary are:

- Identifying educational games and gamification elements
- Developing games
- Testing games
- Publishing and promoting games
- Monitoring user satisfaction.

### **About *Mrežnik***

The *Mrežnik* project aims at creating a free, monolingual, easily searchable, hypertextual, corpus-based, online dictionary of the Croatian standard language. These entries contain definitions, subentries, collocations, examples of usage, normative and pragmatic advice, idioms, references to other entries, and external links. *Mrežnik* is based on the *Croatian Web Repository corpus*<sup>8</sup> and the *hrWaC – Croatian web corpus*<sup>9</sup>. In addition to these sources, all other available print and web sources are considered in writing definitions and selecting examples. *Mrežnik* is created using the TshwaneLex dictionary compilation software to create the desired structure and fields for dictionary entries. *Mrežnik* consists of three modules. In the first phase of the project, the module for adult native speakers of Croatian will have 10,000 entries, the module for school-children 3,000 entries, and the module for non-native speakers of Croatian 1,000 entries (more the project in Hudeček, Mihaljević, 2020). The first demo

<sup>3</sup> <https://h5p.org/> (26. 12. 2021.)

<sup>4</sup> <https://quizlet.com/> (26. 12. 2021.)

<sup>5</sup> <https://www.eclipsecrossword.com/> (26. 12. 2021.)

<sup>6</sup> <https://codepen.io/> (26. 12. 2021.)

<sup>7</sup> <https://github.com/> (26. 12. 2021.)

<sup>8</sup> <http://riznica.ihjj.hr/index.hr.html> (16. 12. 2021.)

<sup>9</sup> <http://nlp.ffzg.hr/resources/corpora/hrwac/> (26. 12. 2021.)

version of *Mrežnik*, which contains entries from letters A to F, was published in October 2021<sup>10</sup>. The demo version allows browsing and searching entries in all three modules. Games based on the dictionary content for all three models were also developed within the project. The first versions of the games were published with a demo version of *Mrežnik*<sup>11</sup>. More about the site in chapter *Publishing and promoting games*.

### ***Identifying educational games and gamification elements on other sites***

Before creating dictionary games for *Mrežnik*, the types of educational games and gamification elements used on websites of lexicographic publications were identified. Hence, the first research question in this paper is:

RQ<sub>1</sub>: *Which gamification elements are present in Croatian and foreign lexicographic e-publications?*

To answer this research question, an analysis of 183 web dictionaries and 76 encyclopedias was conducted from December 2018 to December 2019. The websites were found on the *Wikipedia* lists of lexicographic publications<sup>12</sup> and academic search engines RefSeek<sup>13</sup> and iSEEK<sup>14</sup>. The research showed that only 26 web dictionaries and 10 web encyclopedias contain games or gamification elements. Games identified on these sites are quizzes, drag-n-drop games, puzzles, crosswords, fill in the blanks games, listening games (games for spelling of heard words), offline materials for games, games for finding words, memory, typing games, hangman, and unique games. The table below shows the number of game types in online dictionaries and encyclopedias.

Table 1: Number of game types in online dictionaries and encyclopedias

quiz	drag-n-drop game	puzzles	crosswords	fill in the blanks	games for the spelling of heard words
26	10	6	5	5	5
offline materials for games	unique games	memory	hangman	games for finding words	typing games
5	4	3	3	2	1

Within each of these games and on websites of online dictionaries and encyclopedias, these gamification elements were identified: scoring, levels, time limit, leaderboards, avatar, badges or other award systems, and story with quests. The table below shows the number of gamification elements in online dictionaries and encyclopedias.

Table 2: Number of gamification elements in online dictionaries and encyclopedias

scoring	levels	time limit	leaderboards	avatar	badges or other award systems	story with quests
26	15	13	7	6	6	2

<sup>10</sup> <https://rjecnik.hr/mreznik/> (27. 12. 2021.)

<sup>11</sup> <https://rjecnik.hr/igre/> (27. 12. 2021.)

<sup>12</sup> [https://en.wikipedia.org/wiki/List\\_of\\_online\\_encyclopedias](https://en.wikipedia.org/wiki/List_of_online_encyclopedias) (27. 12. 2021.)

<sup>13</sup> <https://www.refseek.com/> (27. 12. 2021.)

<sup>14</sup> <http://education.iseek.com/iseek/home.page> (27. 12. 2021.)

The tables above show that quizzes are currently the game type that appears most frequently, which is not surprising because quizzes are conceptually and technically the easiest game type to make. Drag-n-drop games follow quizzes in frequency. A dictionary that has the most game types is Merriam-Webster. It has a whole page dedicated to displaying all the games they created<sup>15</sup>.

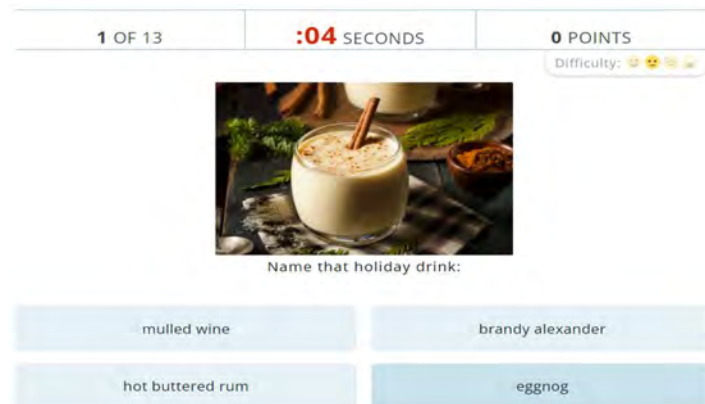


Figure 1: Example of question in holiday party quiz on Merriam-Webster dictionary

Most of these games feature gamification elements of scoring, and some games have levels divided by content or game difficulty adjustment. Most games implement scoring by awarding points to players for every correct answer or fulfilled task. Time limits are usually implemented together with scoring in quizzes. Dictionaries, unlike encyclopedias, do not have any unique games. A story with a quest is the least present gamification element in lexicographic games. The encyclopedia with the most unique game types is Encyclopedia Smithsonian<sup>16</sup> which has many unique simulation games for distributing water across countries, keeping cities safe from natural disasters, building zoos, etc. (Mihaljević, Josip. 2020a: 21)



Figure 2: Game *Aquation: The Freshwater Access Game* from Smitsonia in which you have to manage water distribution and research across the world<sup>17</sup>

<sup>15</sup> <https://www.merriam-webster.com/word-games> (28. 12. 2021.)

<sup>16</sup> <https://www.si.edu/kids> (28. 12. 2021.)

<sup>17</sup> <https://ssec.si.edu/aquation> (28. 12. 2021.)

### ***Identifying games and gamification elements in libraries, archives, and museums***

To get more data about educational game and gamification elements in addition to the previous research question the research was expanded with the following research question:

RQ<sub>2</sub>: *Which gamification elements are present on library, archives, and museum websites?*

To answer that question, 179 museums, 254 libraries, and 21 archive websites were analyzed during 2019. The list of the websites for those institutions was found on Wikipedia sites<sup>18</sup>. It was determined that only 18 libraries, 11 museums, and 2 archives contain games, links to games, or gamification elements. The table below shows the number of game types on archives, libraries, and museum websites.

Table 3: Number of game types on the archive, library, and museum websites

quizzes	puzzles	drag-n-drop games	fill in the blanks	unique games	memory games	crosswords
27	23	18	15	5	3	1

Gamification elements identified within each of these games and on websites are shown in the table below.

Table 4: Number of gamification elements on the archive, library, and museum websites

scoring	levels	story with quests	time limits	avatar	badges or other award systems
28	20	19	15	14	13

From the tables above, we can conclude that there are fewer game types identified on the archive, library, and museum websites than on dictionary and encyclopedia websites (7 game types on the archive, library, and museum websites compared to 12 game types identified for dictionaries and encyclopedias). Like in dictionaries and encyclopedias on the archive, library, and museum websites, quizzes are the game type that occurs most frequently, and scoring is the gamification element that occurs most often. Stories and quests are present more often on these websites because they are appropriate for presenting cultural and historical content as it is easier to tell a story through games (more about this part of the analysis in Mihaljević, 2021b).

### ***Developing games***

The first step in designing dictionary games consists of choosing dictionary content that the creator of games wants to gamify and selecting the targeted group for which the gamified content is developed (e.g. *Mrežnik* has three modules for different user groups: elementary school children, non-native speakers, university students). In *Mrežnik*, before their initial development, games based on dictionary content were also categorized as spelling games,

<sup>18</sup> [https://en.wikipedia.org/wiki/List\\_of\\_libraries](https://en.wikipedia.org/wiki/List_of_libraries) (28. 12. 2021.)

phonological games, morphological games, syntactic games, discourse games, lexical games, word formation games, and games for learning elements of the Croatian culture. Demo games for the three modules of *Mrežnik* were created based on the analysis of present educational games and gamification elements which was done in the previous phase and the decision what type of games needed to be created for which users (Mihaljević, 2020a: 877-890). When games and game elements have been selected, the technical process of developing games can start. First, the adequate technology that can allow creating games based on the decisions made for previous steps have to be chosen. Sometimes this technology, code, or program for developing games has to be tested to see if it allows games to be created based on the concept for the desired game. The selected technology can be used for final game development if testing proves so.

Games for *Mrežnik* were created using accessible technology that had no copyright restrictions. Most of the games were developed through available codes on CodPen and GitHub websites, and some games were developed through the H5P platform. H5P allows creating games through the website user interface and embedding them through HTML code on other websites. Games created through H5P don't have watermarks and copyright restrictions, but customization options are limited because developers don't have access to the game code. H5P was mostly used for creating simple quizzes, e.g., knowledge quiz for high school students<sup>19</sup> and drag-n-drop games for learning phrases<sup>20</sup>. Other game types or games that needed custom designs (such as games for learning the Glagolitic script, which use the FSGLA font for displaying Glagolitic letters) were created from codes available on CodePen and GitHub (Mihaljević, Josip. 2019: 2-3). Some games, such as the typing game for spelling<sup>21</sup> had to be heavily modified from the original code<sup>22</sup> to allow the presentation of certain Croatian letters (č, ć, đ, ž, š) and different graphical designs. For some games, leaderboards were also implemented. Games' leaderboard scores are stored and accessed by games through *Google sheets* using *TabletopJS* script<sup>23</sup>.

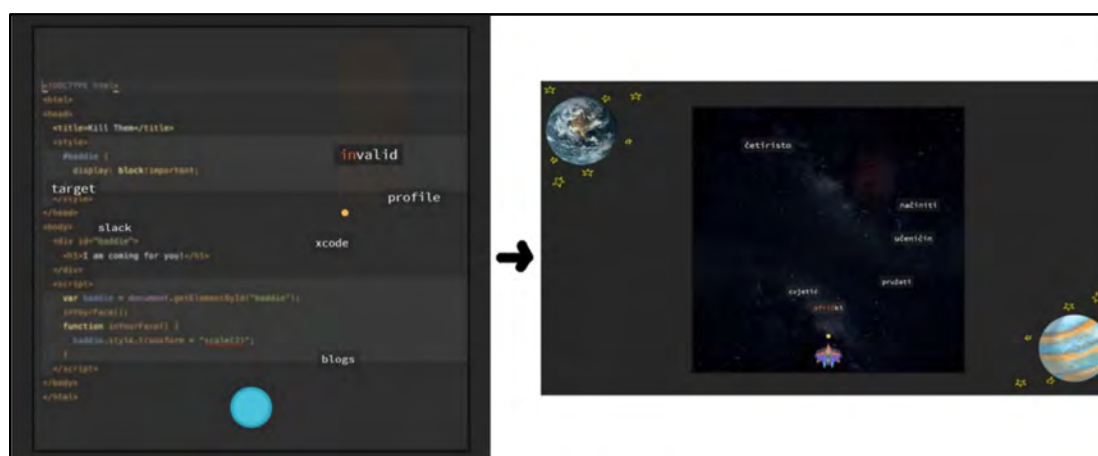


Figure 3: Difference between original typing game on the left with the modified typing game for learning Croatian on the right

<sup>19</sup> <http://hrvatski.hr/igra/2/> (28. 12. 2021.)

<sup>20</sup> <https://jezicneigre.com/frazemi/> (28. 12. 2021.)

<sup>21</sup> <http://hrvatski.hr/igra/4/> (28. 12. 2021.)

<sup>22</sup> <https://codepen.io/jakealbaugh/full/GopoLa> (28. 12. 2021.)

<sup>23</sup> <https://github.com/jsoma/tabletop> (28. 12. 2021.)

The demo versions of the games were published online for testing purposes through GitHub and GitLab repositories. Many different game types are currently being developed, such as quizzes, crosswords, typing games, filling in the blanks, drag-n-drop, memory, etc. As mentioned earlier, they implement the gamification elements such as scoring, leaderboards, levels, time limits, and badges. Some of these games are currently present on websites <https://rjecnik.hr/mreznik/>, <http://hrvatski.hr/>, and <https://jezicneigre.com/>.

### ***Testing games***

Before publishing the final version of games, the games had to be tested so mistakes could be corrected and suggestions could be made for improving the game content or design. The game developer can do game testing, but it is also recommended to have other users who represent the targeted audience for the game test the game and give their feedback. After a few trials, if the game is playable, has no significant problems, and covers everything planned in the concept, it can be published. The demo versions of developed games were first presented to schoolchildren and non-native speakers learning Croatian as a foreign language during their visits to the Institute of Croatian Language and Linguistics<sup>24</sup>. Their reactions were noted, analyzed, and considered for further development of games (more about that in Mihaljević, 2021a). A research was conducted for games developed for azylants and asylum seekers learning Croatian. The games for azylants and asylum seekers are available on the site: [https://bornal2.gitlab.io/igre-mreznik/sadrzaji\\_zastrance/](https://bornal2.gitlab.io/igre-mreznik/sadrzaji_zastrance/) (more about that in Matijević and Mihaljević, 2019).

However, to test the effectiveness of games for non-native speakers, after obtaining permission from the Ethics Committee, research was conducted on two groups of students learning Croatian in Croaticum – Center for Croatian as a Second and Foreign Language. The research was conducted in online classes through the Zoom platform during the pandemic of the COVID-19 disease (from 6<sup>th</sup> April to 22<sup>nd</sup> April 2020). The experimental group (9 students) used games published on GitHub during their class: <https://bornal2.github.io/croaticum/>. The control group (12 students) did not use educational games. To compare their progress, the same vocabulary test was given to students in both groups. At the beginning of the first class, they wrote a pretest to analyze and compare their initial knowledge of the vocabulary learned in the lesson. The posttest, with the same questions as the pretest but in a different order, was given to the students of both groups at the end of the lesson to see their progress. After two weeks, they wrote a delayed posttest, which was again the same as the previous two tests, to check their long-term vocabulary retention. Descriptive statistics created from all three tests for each group are shown below (Table 5, 6, 7).

Table 5: Descriptive statistics of the results of the pretest

	N	average	median	mod	maximum	minimum	range
control group	12	38,08	38	39	30	45	15

<sup>24</sup> <http://ihjj.hr/mreznik/page/usavsavanje-i-diseminacija-2020/30/> (29. 12. 2021.)

experimental group	9	33,67	32	-	27	40	13
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Table 6: Descriptive statistics of the results of the posttest

	N	average	median	mod	maximum	minimum	range
control group	12	44,08	45	46	40	47	7
experimental group	9	42,11	42	44	37	47	10

Table 7: Descriptive statistics of the results of the delayed posttest

	N	average	median	mod	maximum	minimum	range
control group	12	44,42	45	46	40	47	7
experimental group	9	40,78	40	46	35	46	11

The control group showed better results from the start, which can be seen from pretest results (table 5). From descriptive statistics for the first posttest results and delayed posttest results, we can see that students from the experimental group have improved after the pretest, more than the control group, even if they haven't achieved better results than the control group. This is especially true for the posttest, where the average of the experimental group is not much lower than that of the control group.

Students from both groups also completed a short questionnaire after the first posttest. Most students (17) mention using a web dictionary to learn Croatian. Eleven students (six from the experimental group, five from the control group) said that they like playing electronic games, nine students are neutral to them, and only one student does not like playing electronic games. Students from the experimental group also answered a questionnaire about the games used during the experiment. Eight out of nine students enjoyed learning through games. Those students agreed that these games are good, simple, and fun for learning the Croatian language. Two students commented that some games are maybe too simple for advanced learners and that more explanations and examples of word usage could be implemented.

The results of the conducted research implicate that games can help students learn Croatian as a foreign (other) language. More about the conducted research see in Mihaljević (2021:160-220). Based on observation during class, research results, and students' feedback, games developed for the *Mrežnik* project were modified to allow more difficult adjustments and have more examples of using a specific word or explaining a particular language rule.



## Publishing and promoting games

After modifying games based on the previous testing, the games are published and promoted. Promoting can be done through social media before the game is published to attract more interest for the game or, in the case of *Mrežnik*, also to attract more interest for a product supplemented with games. However, promotion should continue after the game is published. In addition to social media, it is also good to have articles written about games on website portals that potential players visit and to promote games on TV programs, in newspapers, and magazines. Another way to promote educational games and get instant feedback is having workshops for learners or teachers. All these promotional activities are planned and have already been partly conducted for *Mrežnik*.

In the case of *Mrežnik*, the games are published on the site <https://rjecnik.hr/igre/>. The site was designed using WordPress. The *Mrežnik* site, also made in WordPress, is available at <https://rjecnik.hr/mreznik/> and is linked to a site containing all the games on the main menu. A unique feature of *Mrežnik*, which was not found on any dictionary or encyclopedia websites, is that links to some games are implemented into the entry structure by external links. Certain dictionary entries have links to games that cover the content of that entry (e.g., entry *abeceda* 'alphabet' which contains the subentry *znakovna abeceda* 'sign alphabet' includes a link to the game designed for learning sign language alphabet<sup>25</sup>).

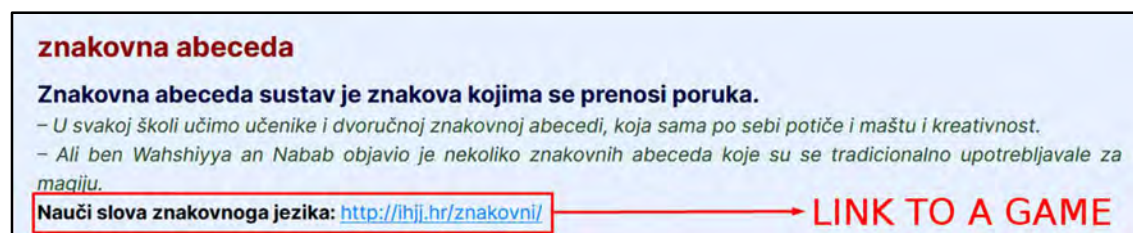


Figure 4: Link for a game for learning sign language inside subentry sign alphabet in *Mrežnik*

The game site is divided by categories and types for easier search. The main categories are target players previously defined by the three modules in *Mrežnik*. Further categorization was based on game content (spelling, grammar, culture, vocabulary, etc.). The game site also has a search bar which allows for faster game search. The site's main page displays the last few games in each of the categories. The games are presented with an image and a short description. When a player clicks on a game's title or image, the game opens in fullscreen mode in a new tab. Regardless of the categories, games are also divided and can be searched by type (e.g., quiz, drag-n-drop, fill in the blanks, memory). Each game has descriptive meta tags (description, **Keywords**) that can help users find the game through a web search.

## Monitoring user satisfaction

The last phase focuses on monitoring user satisfaction. This can also be done through social media since the user can freely give their opinion through likes and comments. Google Analytics can also check which games or parts of games are being played most often. Questionnaires can be given to players online or in person. Player feedback can be used for

<sup>25</sup> <http://ihjj.hr/znakovni/> (1. 4. 2021.)

creating new games, updating the existing ones, adding new content, or improving games. It is essential to interact with the players to continue playing and that you don't lose them in the future. It is also important to expand the current player base with the potential future players gained by recommendations from older players.

## Conclusion

<sup>4</sup>The phases of gamifying *Croatian Web-Dictionary – Mrežnik* are mostly linear, so the next step begins after the previous. However, one can return from the last phase (monitoring user satisfaction) to the second phase because of possible bug fixes or mistakes or updates to the game content based on user feedback. Therefore, by explaining and giving examples for all phases of gamification of *Croatian Web dictionary* and creating games based on the content of the born-digital dictionary *Mrežnik*, we can conclude that it is possible to gamify a dictionary successfully. The phases mentioned in this paper can also be used for gamifying other lexicographic works. These gamification phases can help develop the methodology for gamifying language content in the digital environment. Language games created for *Mrežnik* can help players learn Croatian and dictionary content. The research presented in this paper opens questions that require more research in the future:

- how to modify these phases for gamifying encyclopedias (and possibly archive, museum, and library content);
- how would results of using gamified dictionary content for learning purposes (possibly not online) with larger groups and different groups (this includes not only doing research with non-native speakers) correspond to current case study results;
- will there be a need to identify more educational game types and usable gamification elements in the future due to the development of the game industry?

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## **FAZE IGRIFIKACIJE HRVATSKOGA MREŽNOGA RJEČNIKA (PRIMJER MREŽNIK)**

### **Sažetak**

*Ovaj rad analizira faze igrifikacije Hrvatskoga mrežnog rječnika – Mrežnika. Proces igrifikacije proveden je u Institutu za hrvatski jezik i jezikoslovlje u sklopu projekta Mrežnik. Igre za rječnik napravljene su da pomognu igračima da nauče jezik i usvoje rječničke sadržaje. Mrežnik sadržava tri modula: osnovni za odrasle govornike hrvatskoga jezika koji ima 10 000 natuknica, modul za učenike nižih razreda osnovne škole koji ima 3000 natuknica i modul za neizvorne govornike hrvatskoga jezika koji ima 1000 natuknica. Igre su izrađene na temelju sadržaja svih triju modula te se neke igre još izrađuju. Konceptualni okvir igrifikacije mrežnog rječnika stvoren je usporedno s*

razvojem tih igara te uključuje faze planiranja, dizajniranja, testiranja te ugradnje igara u rječničke natuknice. Prvi korak uključuje identifikaciju i poznavanje tipova igara i mogućih igrifikacijskih elemenata koji se nalaze u rječnicima i drugim leksikografskim izdanjima. Prije izrade igara za Mrežnik, analizirani su tipovi obrazovnih igara i igrifikacijski elementi prisutni na mrežnim stranicama 183 rječnika i 76 enciklopedija. Nakon što su analizirani svi mogući tipovi igara te načini primjene igrifikacijskih elemenata, moglo se započeti s izradom prvih demoinačica igara za Mrežnik, koje sadržavaju igrifikacijske elemente bodovanja, tablice rezultata, razine, vremensko ograničenje i značke. Nakon izrade igre treba testirati. Testiranje je provedeno na igrama koje su izrađene u modulu za neizvorne govornike hrvatskoga jezika te je provedeno istraživanje o učinkovitosti igara na dvjema skupinama studenata koji uče hrvatski kao ini jezik. Rezultati istraživanja pokazuju da igre mogu pomoći studentima u učenju hrvatskoga jezika kao inoga. Igre izrađene unutar modula za učenike nižih razreda osnovne škole predstavljene su učenicima različitih škola koji su posjetili Institut za hrvatski jezik i jezikoslovlje. Igre su izmijenjene na temelju prikupljenih povratnih informacija iz istraživanja te testiranja igara s različitim korisnicima. Posljednje faze igrifikacije uključuju izdavanje i promoviranje igara te praćenje zadovoljstva korisnika.

**Ključne riječi:** igrifikacija, konceptualni okvir, mrežni rječnik, razvoj igara, učenje utemeljeno na igri