Design and Development of a Serious Educational Game for Language Acquisition

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***Abstract*—There are lots of different established scientific theories and frameworks that investigate the processes of human language learning. There are also lots of different established frameworks investigating the production of video games. The goal of this thesis is to take an established learning taxonomy - the Revised Bloom's Taxonomy by Lorin W. Anderson et al. from 2001 and map its practices to well-founded Game Design Ideas by linking cognitive learning processes to Game Concepts, Mechanics, and Objectives. During this thesis a modular Serious Game based on the described concepts will be developed and tested as a proof of concepts and as a possible foundation for future work.**

***Index Terms*—serious games, learning, educational, language,**

I. Motivation

Language [is] a system of conventional spoken, manual (signed), or written symbols by means of which human beings, as members of a social group participants in its culture, express themselves. [1]. Language as a research area has been investigated under four major aspects: (1) Phonology, which is the study of the sounds of languages, (2) Syntax which is the grammar of a language, (3) Semantics which is the study of the meaning of words, and lastly (4) Pragmatics, which is a set of ground rules that settle language usage in social situations [2].

In order to learn a language, pedagogy experts have developed different methods in order to convey proper concepts and procedures regarding any language to students and learners. Among learning techniques and instructional design frameworks, the Revised Bloom's Taxonomy by Lorin W. Anderson et al. from 2001 [3] introduces a tangible overview of cognitive process dimensions as well as defined knwoledge dimensions based on the *Taxonomy of Educational Objectives* by Benjamin Bloom et al. from 1956. It is still widely used in the education system [4] for evaluating learning processes. In the context of language learning, the Revised Bloom's Taxonomy can be especially useful for e.g. evaluating students' abilities to answer questions in reading comprehensions by proposing questions to them that address different levels of thinking processes. The effectiveness of using the taxonomy in this context has been tested and proven in a canadian social science study by Jeyamahla Veeravagu et al. [5]

From a Game Design perspective, there is increasing evidence of the potential of games as learning tools and mechanisms. However, there still is a lack of harmony between the learning content and gameplay. Therefore, the main idea of the current thesis is to evolve a small-scope framework for the design and development of language learning games. The way this should be accomplished, is by defining specific learning objectives and sets of activities to achieve them. More concretely, we propose a mapping between learning elements and game elements in order to achieve a very high level of learning while also maintaining a very high degree of fun. In the context of this project, language learning is limited to the scope of learning a new language after already knowing a native one rather than learning any language for the first time as a toddler. Considering that, concepts would not have to be learned for the first time, but rather mapped to already known concepts in a different language (e.g *Zucchini* in english is mapped to *Courgette* in french).

II. Related Work

There are many applications and games that aim to make language learning more accessible and fun. Some of these have a higher level of gamification and sometimes the knowledge that is learned is really in the center of the application while the gamification level is held rather low. To categorize the related work, we make a gamification grid to categorize the games and applications as well as to visualize their level of gamification and learning objectives. In the final version of the thesis, we will use the Revised Bloom's Taxonomy to list each game's learning objectives, activities and goals. We also list game mechanics, entities, and goals of these games according to the Unifying Game Ontology [6].

Duolingo for example is a mobile app for language learning. It has the claim to teach language by everyday repetition while also continuing to be interesting by built in gamification concepts. For example there is a task, where users have to translate sentences by taping words in the right order or tapping icons that connect to words read out lout by the app and some tasks even require the user to speak

directly into the mobile device to translate vocabularies. The gamification elements within the app include loosing hearts (player lives) when giving wrong answers, loosing daily streaks when missing a learning day or even gems that can be collected through learning sessions that can obtain in-game conveniences.

Vocabicar is a child-friendly racing game that is meant for language learning in early highschool. It has two game modes, one where players get presented a word and have to collect the represented object in a room and collect it by driving through it and in the other game mode players have to collect letters that will sum up to a word that is searched.

When researching for related work, we found it helpful to try to categorize existing games in terms of level of gamification as well as level of learning. The way this can be accomplished for example by using the serious games categorization platform that is currently in development at our chair.

Figure 1: Categorization of Ralated Work

The graph shows a vague categorization of Duolingo and Vocabicar. While Duolingo has a great level of learning, since a lot of different learning tasks can be persued and different cognitive levels of knowledge can be achieved. Duolingo has also a clever system of motivating users to keep learning but it is still not really a playful and dynamic game. Vocabicar is a racing game, that has a high level of gamification, but only vocabularies can be trained and the vocabulary pool as well as the language possibilities are very limited to the level of learning is relatively low compared to Duolingo. Also the target audience in Vocabicar is highschool students only, while Duolingo could be used at any language learning level by anyone.

III. Methodology

The Revised Bloom's Taxonomy (*A.*) as well as the Unifying Game Ontology (*B.*) are described in this section. Our methodology revolves around a proper mapping between learning objectives and activities according to the Revised Bloom's Taxonomy and game mechanics, entities and goals provided by the UGO (*C.*).

A. Instructional Design

The Revised Bloom's Taxonomy is an instructional design framework [3] used to classifying learning objectives of a given topic. This taxonomy proposes six dimensions of cognitive processes that are linked to concrete learning tasks and activities (e.g. the Remembering cognitive process is linked to Recalling and Naming). The second dimension of this taxonomy is about *Knowledge Types* as shown in the table below. Let's also use the taxonomy with concrete examples as it is used to categorize activities in the revised version from 2001 ([3], page 133) by categorizing activities proposed by the Duolingo app from the Related Work part.

	Remember	**Understand**
	Recognize, Recall	Interpret, Exemplify, Classify
Factual Knowledge	*Activity 1*	
Conceptual Knowledge	*Activity 1, Activity 3*	*Activity 2*
Procedural Knowledge	*Activity 4*	
Metacognitive Knowledge		

Figure 2: Categorization of Activities according to RBT

- Activity 1: "Match the picture with the [word]"
  - Task: Tap on the correct image.
- Activity 2: "Translate this sentence [sentence]"
  - Task: Tap on the correct words to form the sentence in the correct order.
- Activity 3: "Tap what you hear [a word is read]"
  - Task: Tap on the correct words.
- Activity 4: "Repeat this sentence [a sentence is read]"
  - Task: Speak the read sentence into your mobile device.

B. Game Elements and Game Design

The Unifying Game Ontology (UGO) [6] tries to disassemble all the low level game elements (goals, entities, mechanics, space, and time) to high level concepts. Each of these aspects are connected to a variety of different more concrete concepts such as *Imperative Goals* ("Choose", "Find", "Remove", etc) that must be executed in order to achieve an *Ultimate Goal* ("Winning", "Finishing", "Prolonging").

In the science of computer games there are many different approaches and takes on what really makes a great game. One approach is the MDA. The MDA is "*[] A formal approach to Game Design and Game Research*" proposed by Robin Hunicke et al. [7]. MDA - standing for "Mechanics, Dynamics and Aesthetics" - proposes the idea that games are more like artifacts than media, meaning that the "*[...] content of a game is its behavior - not the media that streams out of it towards the player*" ([7], page 1). In detail, the framework tries to move away from very abstract vocabulary like "fun" and proposes more concrete concepts like "sensation" as a part of the Aesthetics component meaning the "game as a sense-pleasure" ([7], page 2).

A newer approach proposed by Wolfang Walk et al. in 2017 is called DDE - standing for Design, Dynamics and Experience [8]. It is based on the MDA but proposes a more concrete framework in a diagram form that also respects concepts like the "Player Subject" that for example takes into account that the decision making that individuals make while playing video games differs from the decisions they would make when exposed to a real life event with real life consequences like harm for example. It is based on the theory that "it it is not really us who play games, but a subset of ourselves" ([8], page 9).

C. Learning elements representation in game elements

The first two of the described activities are directly mappable to learning objectives. For example, the **activity** of differentiating a newly learned vocabulary from words that have a different semantic could be mapped to the **game mechanic "Choosing**" that is defined inside the UGO as "Enables and requires the player to decide on a game element for evaluation of the game system." The learning objective of **remembering** the semantics of a vocabulary can be mapped to the **imperative goal of "Finding"** defined inside the UGO as "An imperative that relates to the goal of identifying or locating something in a game."

D. The Concrete Game Design (Game Concept)

The game idea is a cooking game where players have to complete recipes in time in order to complete dishes. These types of games offer an enjoyable gameplay experience without having to focus on story and complex mechanics, which are two aspects that we try to avoid for the course of this game, since the learning should be in the focus.

There can be lots of different activities embedded in a game system like this, that can be mapped to learning objectives:

- Collect the correct ingredients to complete a dish (could map to choosing the correct vocabulary - *remember*)
- Insert ingredients into the cooking pot in the correct order (could map to rearrange words to complete a grammatically correct sentence - *understand*)
- Eliminate an ingredient that does not fit in (could map to finding a translated word that does not fit in thematically - *analyze*)

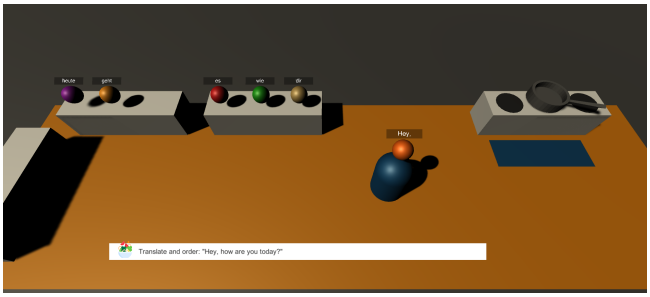

Figure 3: Screenshot of example activity in the first prototype

The screenshot shows an example activity that will be included into the game. The task is to translate the sentence and bring the words into a grammatically correct order. The task is mapped to the player (blue capsule) ordering the different ingredients (colored spheres) by dropping them in the goal area (blue area with pan) in the correct order.

E. Implementation

We are choosing an agile game development approach, where we prototype, improve and reflect over the game design ideas in iterative development cycles. The chosen engine is Unity in its 2020.3 Version, using C# 8.0.

For having a modular game system we are reading Json files into Unity by using the built in JsonUtility feature. This way, different languages could be fed into the game fairly quickly and the knowledgebase could be modified at any time.

The first task into the development will be the design of a Json Datatype that can be read into the game, representing simple bits of knowledge, such as vocabulary. Then there will be a prototype made to test the knowledge from the users. After reflecting and iterating on this stepping stone, more complex Json Datatypes can be developed and embedded into the game.

F. Playtesting and Knowledge retention assessment

When the game reaches a roughly finished state, there will be playtesting sessions with human playtesters that will be asked to fill out Gameplay Questionnaires. This way we can track and check if the learning processes that the game wants to convey reach the audience. The sessions as well as filling out the Questionnaires will likely be held online. There may be several Questionnaires with temporal spacings, to make it easier for us to assess the knowledge retention.

IV. Schedule

A. Literature Review: Weeks (1-3)

- Research about Learning Theory as well as Game Design patterns and how the two could be woven together.
- Definition of a funded mapping between Learning Theory and scientific Game Design patterns.

B. Conceptualization and Iterative Development: Weeks (4-9)

- Prototyping and iterative development work on the game
- Prototypes will be tested and learning processes will be evaluated

C. Thesis writing: Weeks (10-12)

- Concrete writing of Bachelor Thesis
- Detailed description of the iterative development process
- Evaluation of concepts via playtesting and questionnaire results will be added.

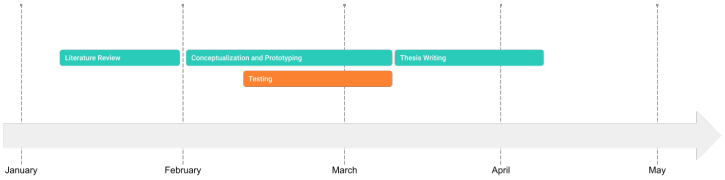

Figure 3:Rough Schedule of Thesis Process

V. References

[1] https://www.britannica.com/topic/language

[2] https://www.sagepub.com/sites/default/files /upm-binaries/57593_Chapter_9_Levine_Sample.pdf

[3] Anderson, Lorin W., et al. "A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives, abridged edition." White Plains, NY: Longman 5.1 (2001).

[4] https://gianfrancoconti.com/2015/06/04/to-what-extent-does-blooms-taxonomy-actually-apply-to-foreign-language-teaching-and-learning/

[5] Veeravagu, Jeyamahla Veeravagu Jeyamahla, et al. "Using Bloom's taxonomy to gauge students' reading comprehension performance." Canadian Social Science 6.3 (2010): 205-212.

[6] Debus, Michael S. "Unifying Game Ontology."

[7] Hunicke, Robin, Marc LeBlanc, and Robert Zubek. "MDA: A formal approach to game design and game research." Proceedings of the AAAI Workshop on Challenges in Game AI. Vol. 4. No. 1. 2004.

[8] Walk, Wolfgang Görlich, Daniel Barrett, Mark. (2017). Design, Dynamics, Experience (DDE): An Advancement of the MDA Framework for Game Design. 10.1007/978-3-319-53088-8_3.