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Adaptive systems as enablers of feedback in English language learning game-based environments

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***Abstract* — This paper presents perspectives on adaptive web-based learning environments, their tasks, functions, techniques and methods. The main categories, types and layers of adaptive learning systems as well as different forms of feedback used in these environments were examined. The significance of feedback becomes emphasized in learning environments because it helps to plan the student's learning path, provide information about their progress, note the important information and guide the student along the learning process. This work introduces an evaluation framework for the analysis of game-based learning environments by the main criteria used in adaptive learning games. The analysis is focused on various learning environments, specifically applications and games for English language learning. The analysis results in an evaluation of 23 game-based learning environments and applications that are developed for the purposes of English learning. The relationship between the feedback types and areas of English learning is presented.**

Keywords — adaptive learning system; game-based learning environment; feedback system; English-learning games

I. INTRODUCTION

In recent years, there has been a growing interest towards utilizing adaptive intelligent technologies in creating learning environments for enhancing more personalized education. The use of these technologies contributes to improving the quality of education, as well as reducing the time required for mastering learning content. Learning environments that adjust themselves according to the needs and abilities of individual users or groups of users are called adaptive learning systems.

Adaptive learning systems allow organizing content, identifying the way to learn according to learner's knowledge and use assessment results to provide personalized feedback to each learner [1]. Adaptation of the learning process implies a change in the sequence of the studied topics and visual representation of each viewing page. The quality of the educational process in web-based learning systems depends on the use of adaptive technology, methods and built-in mechanisms.

This paper provides a short review on existing adaptive game-based learning systems, specifically concentrating on English language learning. The use of game-based learning in English language learning has spread on a wide area including games and applications that may be used, for instance, for vocabulary and grammar learning, pronunciation and listening comprehension, and it has been proved to improve learning [2], [3], [4]. However, as the previous studies reveal, research in the area of feedback in applications and games has not yet been conducted to a large extent and at the same time the amount of students hoping to improve their language skills by using e-learning tools is increasing. As Belotti F. et al. [5] point out, technology and various tools can be used to provide a learner with assessment and feedback without the presence of an instructor or a teacher.

The problem of assessing the quality of adaptive learning system, the problem of choosing technologies and methods for constructing such adaptive systems, as well as determination of the causes of low efficiency of learning are relevant for the development of such systems.

Despite the fact that significant results have been achieved in the area of adaptive learning systems, including practical ones, there are not any defined evaluation criteria and optimal components for these systems, nor are there any specific requirements for the construction of logical and structural models for these systems. In order to build a good quality adaptive game-based learning system, developers have to understand the main criteria for the evaluation of these systems.

This paper consists of five sections. Section 2 presents general information about adaptive learning systems and their division according to types, methods, technologies, features and levels. Section 3 opens a discussion about the meaning of feedback in game-based learning environments, especially focusing on English learning. Section 4 presents a design of evaluation framework for adaptive English learning game-based environments and criteria for this evaluation. Section 5 concludes the paper by presenting results in 23 evaluated game-based learning environments according to feedback types. It presents feedback types used in different English learning areas, addressed in selected game-based learning environments, and the relationship of English learning areas to the types of feedback.

II. CONTEXT OF THE ADAPTIVE LEARNING SYSTEM

A. Adaptive Learning and Adaptive Learning Systems

According to Gifford T. [6] adaptive learning is a method that is centered on "creating a learning experience that is unique" for every individual learner through the intervention of computer software. Adaptation in learning can be viewed from several different aspects: adaptation to the current needs of particular learner; adaptation to a particular learner's state; adaptation to a chosen specific field for studying and adaptation to a specific task.

According to Sonwalkar N. [1], adaptive learning systems are technological systems that are capable of adapting and learning depending on received input signals. Intelligent adaptive learning observes each decision a student makes and

adapts the student's learning pathway (or produces many personalized learning paths, which are specifically designed to a student's unique needs).

The goal of an adaptive learning system is to individualize learning so it becomes possible to improve or stimulate student's performance gain. According to Weber G. [7] the system is able to "enhance the individual learning process with respect to speed, accuracy, quality and quantity of learning". Adaptive learning systems are intended to identify what a student does and does not understand, identify and provide content that will help the student learn it, assess again, help again, etc., until a defined learning goal is achieved [8].

Adaptive distance learning systems have a number of advantages, the main ones being: providing opportunities to choose student's own path of learning; differential approach to learning based on the fact that each learning experience and knowledge in one area that determines the degree of understanding of the new material is different; increasing objectivity and knowledge control efficiency of the student; individualization of learning activities; and increasing motivation and activation of cognitive activity of students.

B. Types,Technologies, Methods, Levels and Features of Adaptive Learning Systems

Earlier research has indicated that adaptive systems can be defined according to their types [8], utilized technologies [9], [10] methods for building these systems [11], [12], [13], [14], levels [8] and features [15], [16].

The main types of adaptive learning systems are simpler adaptive systems and those that are algorithm-based [8]. Simpler adaptive systems are based on rules and are more content-oriented. They are easier to understand in terms of functionality; however they are less adaptive to individual needs of students. Here is an example of a system flow: the system asks the user a question, and if the answer is correct, it continues to the next one. If the given answer is incorrect, the system helps the user by displaying additional information, e.g. a hint, same learning material repeated, additional learning material, explaining the matter in a different way, etc. Algorithm-based systems are based on advanced mathematical formulas and machine learning concepts. These systems are more complex. Such systems may make use of educational data mining and advanced analytics to deal with big data, and employ complex algorithms for predicting probabilities of a particular student being successful in learning particular content.

There are two main technologies utilized in the design of adaptive systems: Adaptive Hypermedia Systems and Intelligent Tutoring Systems [10]. Adaptive Hypermedia Systems include adaptive presentation and adaptive navigation support. Intelligent Tutoring Systems include curriculum sequencing, intelligent solution analysis and problem solving support.

Adaptive and intelligent technologies can significantly improve the quality of distance education systems. Adaptive presentation can improve the usability of course material. Adaptive navigation support and adaptive curriculum sequencing can be used for full control over the course and to aid in selecting the most appropriate information and regulations. Problem solving support and intelligent solution analysis can significantly improve the quality of software requirements, and make teachers' work easier.

Many techniques and methods have been utilized in the development of adaptive learning systems [11], [12], [13], [14]. The main methods include the data-based inference method (case-based reasoning, machine learning, collaboration filtering), theory-based inference method (Bayesian networks, Naive Bayes analysis, fuzzy logic, Dempster-Shafer theory of evidence) and decision-making methods (influence diagrams, decision theoretic planning). Some of the techniques are using learning style (MBTI, Kolb's, Felder-Silverman, and The Vark) and some are using technologies based on Semantics (ontologies, agent-based, etc.).

The levels of adaptivity are determined according to the complexity of a system. Verdugo D. and Belmonte I. [4] present five levels, which differ in regard of complexity and features.

Level 1: Students complete a quiz after reading the material and the system provides feedback informing the student on whether or not the given answer was correct.

Level 2: Same as in Level 1. In addition, the system provides some explanations detailing why some answers were incorrect, as well as presenting a link to the material for a review.

Level 3: Same as in Level 1. Furthermore, the system gives a recommendation about the material to read. In the next quiz, the system will add the questions that have been answered incorrectly in the previous section to see if the student has mastered the material. Students can track their progress on the dashboard.

Level 4: The student studies learning material and then completes quizzes on it. Based on the results, the system provides an individualized learning plan that aims to fill any possible gaps in the student's knowledge. After completing the plan, the student completes another quiz to see whether he or she has made progress.

Level 5: A student is given a problem, and asked to fill in the gaps for each step along the way to a solution. Feedback is given right after each step or after the whole quiz. The feedback is based on the analysis of the steps the student has taken, compared to the most effective methods for solving such a problem. The system then selects the next question based on student's readiness.

The features of adaptive systems describe and provide relevant content and support, and guide the learner through the adaptive learning system and the accompanying courses [15]. The author divides such features into the following five categories according to the functions that a system can have.

- Pre-test: when the system begins with an assessment of current knowledge and skills. This assessment gathers information about personal learner characteristics, which include prior knowledge on the subject domain.
- Pacing and control: when a learner has control over certain aspects of the system, such as controlling the speed with which the content is presented, or the order in which the content is presented, among others.
- Feedback and assessment: when the system evaluates learner's progress and gives feedback according to his/her performance. Feedback can be presented as correct/incorrect responses, or the system can recommend material, resources and suggest some possibilities for additional practice.

- Progress tracking and reports: when the system can save the user's profile with his/her progress, and the user has a possibility to start from where he/she left off. System can also generate some periodic progress tracking according to individual progress.
- Motivation and reward: when the system includes gamification elements to motivate its users. This can involve rewards (points, stars, badges) for passing levels, and its aim is to advance the users' performance and achievement.

According to Paramythis A. and Loidl-Reisinger [16], there is one extra feature that could be used for defining adaptive learning systems. This feature is about understanding the student's requirements and preferences.

III. The Meaning of Feedback in Game-based Learning Environments

A. Feedback Types and Formes Used in Game-based Learning Environments

The significance of feedback becomes emphasized in learning environments and games because it helps to plan the student's learning path, provides information about his/her progress, notes the important information and guides a the learner through the learning process [17], [18]. In games and learning platforms, feedback can improve learning and help the learner to make decisions about his/her learning strategy, while also increasing the learner's motivation [19]. Breuer and Bente [20] (as quoted by Bellotti et al., 2013) state that incorporating the elements of assessment into games makes assessment more invisible and enables a more thorough use of the medium itself.

In the definition of Mory E. [21], feedback is any message that is generated in response to a learner's action, usually after the learner has completed a particular task or function. It implies that there is an "interactive flow between the learner and the system, coming from some information collected or generated by the learner and coming back to him as an output after some processing".

There are many existing studies based on categorization of feedback. Table 1 presents the number of feedback types [22], [23], [24], [25], [26] and their description.

According to the provided descriptions of each feedback type in Table 1, it could be argued that informative and conformational feedbacks are closely related to each other. These types of feedback only provide information on whether the answer is correct or not. Likewise, instructive and corrective feedbacks are also closely related, because they provide corrections and instructions on how to get the correct answer. Explanatory and elaborative feedbacks are also concentrated on similar things, providing explanations of why the answer provided by the user is wrong. Information-based and point-based feedbacks are closely related, because they provide the accuracy and quality of answers in levels of mastery, progress bars, cumulative points, etc.

Taking into account that some of the feedback types have the same functions, this study used a combination of feedback types, specifically informative, corrective, explanatory, diagnostic, point-based, consequence-based and interactional feedbacks provided by Kinzer C. et al. [22], McNamara et al. [23], Kapp K. [24] and Mackey A. [25]. These types are related to the features used in adaptive learning games and applications in area of English learning.

TABLE I. Feedback Types

Author	Type	Description
Kinzer C. et.al. [22]	informative	provides information on results, does not explain why the results are right or wrong.
Mory E. [21]	informative	is focused on self-regulation, related to the context where learning takes place.
McNamara et. al [23]	information-based	is concentrated on providing the accuracy and quality of answers and actions including immediate corrections, delayed corrections, level of mastery achieved on specific content.
McNamara et. al. [23]	point-based	can be conveyed in the form of cumulative points, progress bars, and levels.
Kapp K.[24]	conformational	indicates the degree of "rightness" or "wrongness" of a response, action, or activity. Feedback immediately informs the learner if he or she did the right thing, the wrong thing, or if it was somewhere in the middle. This feedback doesn't tell the learner how to correct the action.
Mory E. [21]	instructive	is related to the knowledge domain. It provides instructions on how to get right answer.
Kapp K. [24]	corrective	guides a learner with instructions. If the learner did the wrong thing, he or she will be prompted, guided, or pointed toward a more appropriate action. Corrective feedback informs the learner that their response was incorrect and provides knowledge of the correct or desired response.
Kapp K.[24]	diagnostic	provides diagnosis about incorrect answers. It defines why the incorrect response was chosen, corrects those common mistakes through the feedback.
McNamara et. al [23]	consequence-based	is a type where the system reacts to the user's responses or actions by changing the system path (paths of actions taken by the system).
Kinzer et.al. [22]	elaborative	provides more information about why an answer was wrong and what has to be done to correct an error.
Kapp K. [24]	explanatory	works as corrective feedback but it also includes relevant information about why an answer is correct or incorrect. It provides a rich explanation to a learner for effective encryption of knowledge.
Mackey A. [25]	interactional	provides the receiver of the feedback with corrective feedback based on learner's utterances, for instance, on pronunciation or articles. Used frequently in language learning applications and games

B. Game-based learning in English Learning and the Significance of Feedback

In order to analyze various English learning applications and games, it is important to understand the underlying processes normally associated with language learning. As we think about language learning as a process, we normally associate certain features to it: listening, reading, speaking and writing. Of these four, the first two are receptive skills, which

normally precede the following two productive skills, speaking and writing. Johnson K. [26] notes, however, that these skills are frequently intertwined, e.g. a learner working on a writing exercise can benefit from previous speaking exercises. Learning grammar and vocabulary are also frequently connected to mastering a foreign language.

There are, however, more thorough ways of categorizing the skills involved in foreign language learning and acquisition. Johnson K. [26] has divided the process of learning a language, basing the division on an earlier model by Canale, M. and Swain, M. [27], into three various parts: systemic competence, sociolinguistic competence and strategic competence. In order for a person to master a language properly, he/she has to be familiar with the various sounds in the target language, the rules that apply to that specific grammar and the lexis, that is, the vocabulary or words of the language. These components form an important ground for further knowledge of language learning. The sociolinguistic competence, on the other hand, entails the cultural norms that one has to take into account when speaking a certain language. This area of language includes, for instance, the codes of being polite in a specific culture language wise. The last one, strategic competence, and covers a language user's ability to handle situations where the right type of vocabulary, for instance, is not found.

At this point it is important to mention that the focus of the present study is on foreign language learning and acquisition which diverges itself from the process of the natural first language acquisition [26]. As explained by Krashen S. and Terrel T. [28] language learning follows certain paths and learners typically acquire certain language features in a certain order. According to the natural order hypothesis, grammatical morphemes, for instance, are acquired in a highly organized manner by children and adults with progressive from preceding articles, irregular past forms and possessive forms [28].

Many studies conducted in the field of English learning with games and applications give proof that they improve learning outcomes for students. Aghlara L. and Tamjid N. in [29] discovered in their study aimed at Iranian, six- to seven-year-old girls that vocabulary of animals, family members, numbers and colors was acquired more efficiently with a software game than with traditional teaching tools, such as blackboards and flash cards, which was explained by the increased motivation of children playing the game. Verdugo D. and Belmonte I. in [4] also share the same result with children's listening comprehension. They studied six-year-old Spanish learners and concluded that the children learning with digital stories improved their skills in listening comprehension more compared to those learning with traditional methods. Verdugo D. and Belmonte I. in [4] mention the more focused way of learning and individual learning pace as key elements that favor the use of digital stories as a form of developing learners' listening comprehension. Vocabulary acquisition and learning with applications and games has been examined in many studies. Cobb T. and Horst M. in [3] studied the word acquisition process with a vocabulary training system and they concluded that with the use of the system in language learning, significant results were achieved. During a two-month period, participants learned the amount of vocabulary that in a normal classroom setting is achieved in one to two years. Aghlara and Tamjid [29] share this result and they further state that vocabulary, in addition to the increased speed of learning, is also retained longer in the memory of a learner with online games compared to the traditional classroom environment. Yip F. and Kwan A. in [30] imply that the enhanced learning experience created by a mobile English vocabulary learning system is explained by a more personal and flexible learning method.

Games and applications for learning may include various elements for signaling how a player has succeeded in it. The most common, and perhaps the most simple, form of receiving feedback in educational English learning games is to signal the right and wrong answers, for instance, by giving awards for correct answers. Aghlara L. and Tamjid N. in [29] studied a game for English vocabulary learning which offers confetti for every right answer whereas a wrong answer will be delivered in the form of a squashed tomato. Scoring is another popular method of providing feedback for learners [31]. With scoring, learners are able to see how others have succeeded in the game but most importantly they are being informed of which aspects are the most significant in the learning process. Michael D. and Chen S. in [32] have studied the effect of an automatic scoring system in an application for rehearsing English pronunciation. The benefit of such system is that a teacher is not required to provide a learner with corrections but the feedback is provided automatically by the system. This type of a feedback mechanism is able to provide the learner with feedback, for instance, on mispronounced phones. This type of a mechanism is able to tackle areas such as spectral match, phone duration, word duration and speech rate in foreign language learner's pronunciation [33]. Chen C. and Chung C. in [31] studied vocabulary learning with a personalized mobile English vocabulary learning system that uses the collected information to improve the learning process. The idea of the system is to first to determine the learner's vocabulary skills with a pre-test after which the learner is able to proceed to the actual learning process based on the test results. A learner is first provided with a rehearsing mode of the targeted vocabulary, which is followed by a test mode. The learning process is stored in a personal portfolio showing the learner the progress with the vocabulary. The improved learning with the system is connected to the system's ability to recommend a learner with appropriate vocabulary.

As language learning is a complex process, the feedback and assessment techniques utilized in the games and applications should support a learner to acquire and master areas in language learning, such as vocabulary, grammar and pronunciation. Sandberg J. et al. [34] summarize that such support could be provided to a learner by offering more difficult content (such as words) more often, providing feedback that goes deeper than just pointing out the correct and wrong answers (e.g. explanations), taking in the information and knowledge a learner already possesses on the subject, and offering a learner with formative tests and assigning new study objects based on the results.

IV. Research Methods and Design

A. Procedure

Previous studies used criteria for the evaluation of learning systems mostly from the perspectives of technology and education. Yip and Kwan [35] used two criteria for the evaluation of educational websites: an educational perspective and a technical perspective. Educational perspective concentrated mostly on information quality, and technical perspective concentrated on navigation, consistent look of the websites and the use of multimedia-like enhancement. Wood [36] discussed in his work desirable criteria related to technical features of vocabulary websites, such as animations, sound components, hints or clues, multimodal presentation of information, and online definitions for the words. Cowan [37]

suggested to use criteria such as relevance, peer interaction, continuous motivation and minimum equipment.

As for the evaluation of adaptive learning systems, the criteria that has been used [38], [39], [40] has been based on evaluation of input data, inference, adaptive decision, total interaction, predictability, privacy, controllability, breadth of experience, unobtrusiveness, timeliness, aesthetics, necessity, consistency, etc.

In order to make an evaluation framework for the adaptive learning applications and games in English learning, we used criteria that is based on defining adaptive learning systems and feedback types in those systems. In this study, we concentrated on various areas of English learning, age level, adaptive system features which were based on combining features discussed in Section B of Chapter 2 with features of feedback, types of feedback, levels of adaptivity and types of adaptive learning systems. The analysis is not based on the techniques and methods of adaptive learning systems, but mostly on the features of these systems for defining types of feedback and levels of adaptivity.

B. Description of Evaluated Game-based Applications for English learning.

In order to reach a sufficient amount of games and learning solutions for the evaluation process, many searchers were executed through Google. Searching in Google was considered to provide us with the broadest selection of English games. The following search terms were used: "games for English learners", "best apps for English learning", "best apps for learning English grammar", "best apps for learning English vocabulary", "applications for English language learners" "online games for English language learner", "best applications for language learning", as well as "adaptive learning in English language teaching", "adaptive games for English learning", "intelligent learning games for English learning", "smart games for English learning", and "intelligent learning applications for English learning".

Games and learning solutions were also selected based on their availability, namely whether they were free of charge for users. There were many web-based applications; some of which could be used on tablets or mobile phones. The applications that clearly did not include gaming aspects or that did not give learners the opportunity to exercise their language skills were excluded from the evaluation. Various sites were then browsed through in order to discover whether there were games that frequently surfaced after which they were included in the study.

In the following phase, 23 games were selected for the evaluation process. Both applications and games were included in the study, in order to construct as comprehensive a picture of the various feedback features as possible. Applications and games were selected in a way that they represent different aspects to language learning, covering areas from systemic and sociolinguistic competence, as explained by Canale M. and Swain M. [27] to the four significant skills of language learning, those of reading, writing, listening and speaking. The analysis included altogether 23 English learning applications or games ranging from colorful vocabulary games for preschool children to more comprehensive individualized learning paths for adult learners. Many of the applications and games could be used for several educational levels; three were targeting pre-school children, nine primary school students, 17 junior high school students, 15 high school students and 16 adult learners. The applications and games were also selected to cover the various language proficiency levels from beginner levels to the more advanced proficiencies. 15 of the applications and games included the beginner level, 18 the intermediate level and 15 the advanced level.

C. Criteria for the Evaluation Framework

For the analysis of the selected English learning games and applications, a table was created, in which evaluation criteria such as application name, area of English learning, grade, level of knowledge, learning system features, types of feedback in those systems, levels of adaptivity and types of adaptive systems was used.

Areas for English learning, such as grammar, vocabulary, reading, writing, listening, speaking and culture, were listed. Preschool, primary school, junior high school, high school and adult learners were used in the analysis of grade/age. Such levels as beginner, intermediate and advanced were used in the analysis of level of knowledge.

For the analysis of adaptive system features we used a list of features according to our research in Section 2:

1) Checking the right or wrong answer: the system simply tells the user if the given answer is correct or not.

2) Providing hints: the system gives hints if a user is struggling.

3) Providing explanation: in the case of an incorrect answer, the system explains why the answer is incorrect.

4) Understanding the users' requirements and preferences: the system asks questions about the user's hobbies, preferences and goals.

5) Progress tracking and reports: the system can track the user's progress and the user can see it on his/her dashboard.

6) Updating information according to user's actions: the system changes the material to be learned according to the' user's progress.

7) Diagnosis of the users' mistakes: the system detects why the answer were answered as wrong.

8) Having a live discussion with a tutor: this could be with a native speaker of with a tutor.

9) Pre-test: the system conducts a pre-test to detect the user's level of knowledge and to provide recommendations.

10) Pacing and control: the option to control speed, select a level, change courses, etc.

11) Providing recommendations: when the system recommends what material to study.

12) Motivation and rewards: the system provides rewards for the user, which can be used to move to next levels or when competing with other users.

13) Creation of learning path: the system creates an individualized learning plan.

The first eight features are related to feedback type recognition. In our study, we used seven types of feedback:

1) Informative feedback: includes feature 1.

2) Corrective feedback: includes feature 1 and feature 2.

3) Explanatory feedback: includes feature 1 and feature 3.

4) Diagnostic feedback: includes feature 1 and feature 7.

5) Point-based feedback: includes feature 1 and feature 5.

6) Consequence-based feedback: includes feature 1 and feature 6, also not obligatory is feature 4.

7) Interactional feedback: includes feature 8.

Rule-based and algorithm-based systems were used as types of adaptive systems. Five different levels were used for adaptive systems according to our research in Section 2.

Level 1 includes feature 1(checking right or wrong answer).

Level 2 includes feature 1 (checking right or wrong answer) and feature 3 (providing explanation).

Level 3 includes feature 1 (checking right or wrong answer), feature 11 (providing recommendations), feature 5 (progress tracking and reports) and feature 6 (updating information according to users actions).

Level 4 includes feature 1 (checking right or wrong answer) and feature 13 (creation of learning path).

Level 5 includes feature 1 (checking right or wrong answer) and feature 7 (diagnosis of users' mistakes).

V. Results and Discussion

23 game-based environments and applications that included different types of feedback were analyzed in the paper.

After the analysis of the selected applications, we also found other criteria which could be taken into account, such as: collaboration (ability to learn together with someone), mobility (users could use applications on tablets, not only on computers), having how-to videos with explanations, having a discussion area, etc.

The applications and games in the present study can be categorized into four sections: applications and games for grammar (5 out of 23), vocabulary (8 out of 23), speaking (pronunciation) (2 out of 23) and applications that include multiple language learning goals (8 out of 23).

In addition, a deviation of main and second areas of English language learning was applied. Main area has number "1" for the analysis. Secondary areas have number "2". If a system does not include a specific area, it is signaled with a "0". According to Table 2, there are 12 applications that have grammar as one of the main areas of English learning. 16 applications have vocabulary as one of the main areas of English learning. Ten applications have reading as one of the main areas of English learning. Seven applications have writing as one of the main areas of English learning. Nine applications have listening as one of the main areas of English learning. Seven applications have speaking as one of the main areas of English learning. Zero applications have culture as one of the main areas of English learning, but seven applications have culture as secondary area of English language learning.

According to the number of features in applications (discussed in Section 4), we detected the types of feedback that each system uses and the level of adaptivity in these systems. The level of adaptivity 1 is more common (appears 12 times out of 23) because it is a more simple one. Level of adaptivity 2 appears 8 times out of 23 and level of adaptivity 3 appears 3 times out of 23.

Other levels need to have more features. The most common feedback types are informative feedback and point-based feedback. Diagnostic feedback does not appear in the list of analyzed applications. This type of feedback appears more in high-level adaptive learning systems.

TABLE II. Survey of the English Learning Areas and the Feedback Types Used in Those Areas

Application (game-based environment)	Grammar	Vocabulary	Culture	Reading	Writing	Listening	Speaking	Type of feedback
Grammar up	1	2	0	2	0	0	0	3,5
Practice English Grammar	1	2	0	2	2	0	0	3,5
Grammaropolis	1	2	0	2	0	2	0	3,5
British council's learn Enlish grammar	1	2	0	1	2	0	0	1,5
IKnow!	0	1	2	2	2	2	1	2,5
PowerVocab Word Game	0	1	0	1	0	2	0	2, 5
Knowji	0	1	0	2	2	2	2	1,5,6
Bitsboard	0	1	0	2	2	2	0	2,5
Arcademics	2	1	0	2	0	0	0	2,5
Quizlet	2	1	0	2	2	0	0	1
Speaking pal	0	2	2	2	0	2	1	1,5
Hawina	0	1	2	2	0	2	1	1,5
Duolingo	1	1	2	2	1	1	1	3,5,6
Busuu	0	2	0	1	2	1	0	1
The interactive grammar of English	1	2	0	2	0	0	0	3,5
Rosetta Stone	1	1	2	2	1	1	1	1,5,7
LinguaLeo	1	1	2	1	1	1	0	1,6
SHAIEx	0	1	0	1	0	1	0	1,6
Agnitus Personal Learning Program	0	1	0	1	2	2	0	1,5,6
Scootpad	1	1	0	1	1	1	1	2,5,6
Voxy	1	1	2	1	1	1	2	1,5,6,7
Babbel	1	1	0	2	1	1	2	2,3,5
Livemocha	1	1	2	1	1	1	2	3,7

As an experiment, we analyzed the relationship of English learning areas to the types of feedback. As shown in Table 2, one game or application can have several areas of English learning and several feedback types.

In Table 3, the relationship between the English learning area and the feedback types is presented in percentages, knowing the total amount of applications and the frequency of feedback type in a selected area.

We discovered that there are similar features in applications targeting the same types of language skills. In English learning areas like grammar, vocabulary and reading, the most common type of feedback is informative and point-based. Vocabulary also has corrective feedback. In the English learning areas such as writing, listening and speaking all feedback types are almost equally presented (but with the frequency under 6) except of diagnostic feedback. As culture is not a very popular are of English learning, it has a low frequency of informative, explanatory and point-based feedback in secondary area of English language learning.

TABLE III. RELATIONSHIP BETWEEN THE ENGLISH LEARNING AREA AND THE FEEDBACK TYPES, %

	Type of feedback						
Area	*informative*	*corrective*	*explanatory*	*diagnostic*	*point-based*	*consequence-based*	*interactional*
Grammar	17,4	9	30	0	44	17,4	13
Vocabulary	35	26	13	0	12	30	13
Reading	26	9	4,3	0	21,7	21,7	8,7
Writing	13	8,7	13	0	21,7	17	13
Listening	21,7	8,7	8,7	0	21,7	21,7	13
Speaking	17,4	4,3	8,7	0	26	13	13
Culture (only for secondary area)	4,3	0	4,3	0	4,3	0	0

Informative feedback is basically incorporated into each application and game that we examined in our analysis, and it typically takes the form of simply signaling a learner with either a correct or an incorrect answer. Corrective feedback is almost identical with informative feedback also entailing the part of informing a learner about the correctness of the answer (explicit correction). There are examples where the right answer is simply explicitly stated to a learner. Alternatively, the system briefly shows the correct answer after which a learner corrects the answer accordingly. Metalinguistic feedback, also a part of corrective feedback, on the other hand, is in one application interpreted to represent a situation that points out the incorrect parts for a learner without actually stating how to correct it. One application we analyzed included a clarification request that was a part of a speaking exercise. Examples of explanatory feedback typically include a brief explanation following the wrong (sometimes also the correct) answer. Some of the grammar specific applications and games analyzed have explanations about grammar rules that are not necessarily connected to exercises or games. Each of the applications and analyzed games incorporated at least some elements of point-based feedback in the form of cumulative points, progress bars or levels or a combination of the three. Interactional feedback is rather difficult to analyze since it can be interpreted in many ways. Naturally all of the applications and analyzed games include some interactional elements such as instant information about the correctness of the answer. There are, however, some applications that allow a learner to discuss the learning process with other users therefore making the learning experience even more interactional.

Most of the English learning applications have multiple learning goals; therefore, it is difficult to separate the various language areas from each other. Furthermore, in many cases, the applications are not targeted for a specific group but they offer a creation of a personalized learning path.

CONCLUSION

In this article, we presented a short review on adaptive web-based learning environments and applications according to their tasks, functions, techniques, methods and levels. We examined feedback, which is an important feature of all adaptive learning systems. According to the selected adaptive game-based environments and applications based on English learning, we found some similarities in feedback types according to a specific English learning area.

The main problem in analyzing the contents and various feedback features of English learning applications and games is that at most times they are complex systems targeting multiple language learning goals simultaneously. Therefore, it is rather difficult to divide the applications based on any one area of language learning, e.g. grammar or vocabulary. Instead, the trend in the applications for English learning at present time seems to be the aim to provide a language learner with a personalized learning path that leads a learner from the beginning steps of language to the more advanced levels.

According to our results, we can say that the more complex feedback types the system has, the more adaptive it will be. Therefore, it is very important to know which types of feedback to use while creating adaptive learning systems with high level of adaptivity. Feedback is an important feature of the adaptive learning systems since it can help to guide users. They can see how they are progressing and what needs to be improved. If there are any problems with answering questions and a learner is struggling, embedded feedback should provide hints and explanations to support the learning process. When a learner has some incorrect answers, the system should include the same questions in the next lessons to see if a learner can solve the task according to provided instructions and learned material.

The findings from the present study function as important guidelines for the developers of various applications and games for English language learning. The users of the applications and games will also get some ideas to select the best tools to guide them in the language learning process.

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