Vocabulary Treatment in Adventure and Role-Playing Games: A Playground for Adaptation and Adaptivity

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Abstract. Although there is pedagogical support for using computer adventure and role-playing games in order to learn a second language (L2), commercial games often lack the instructional qualities for making their language comprehensible for learners. In an interdisciplinary approach, this paper proposes a technique for adapting in-game text in order to teach L2 vocabulary, grounded in research on second language acquisition and adaptive learning systems.

Keywords: adventure games, role-playing games, second language acquisition, vocabulary learning, input enhancement, adaptive learning systems, adaptivity

1 Introduction

Computer adventure games, such as *(Colossal) Adventure*, *Zork* and *Hugo's House of Horrors*, and role-playing games (RPGs) such as *Finaly Fantasy* and *Divinity 2: Ego Draconis*, are genres of digital games in which the player assumes some kind of role in an interactive fictional story. The game unravels mainly through the player's interaction with a preprogrammed plot rather than through physical challenge. The game mechanism is centered around dialogues with computer-driven non-player characters (NPCs), often in the form of point-and-click dialogue trees or through (relatively) free text input, which is then parsed by the programme. RPGs differ from adventure games in that they generally also have episodes of physical action, and have rather complex internal economies and points management systems, but both genres share a focus on story and language, which makes them examples of interactive fiction.

Computer adventure games and RPGs may facilitate the acquisition of a second language (L2). Besides their presupposed effects on learner motivation, they have some characteristics that are interesting from an instructional point

of view. Adventure games have for some time been associated with the development of communicative fluency [1]. First and foremost, they do not focus on language as such, i.e. they create immersive contexts in which language must be put to use, and in which grammar and vocabulary are subordinate to the functions, uses and pragmatics of language. Adventure games, in other words, entail a focus on meaning, rather than a focus on isolated linguistic forms, which creates possibilities for the incidental learning of a L2. This puts these games on a par with contemporary language teaching methodologies such as task-based language teaching [2]. Secondly, computer adventure games stimulate discovery learning, because rather than being confronted with the linguistic forms and functions as such, learners have to experiment with and unveil the underlying structures. Thirdly, adventure games generate opportunities for collaborative learning, either in physical spaces or on-line, as learners may discuss with peers the next or previous moves in the story. And finally, activities in and outside these games stimulate the integrative development of the four language skills of reading, listening, writing and speaking.

Despite generally enthusiastic accounts, commercially available adventure games and RPGs are being criticized from a pedagogical point of view (see e.g. [3]). Although these games undeniably contain the most language of all game genres, the kind of language and the way language is presented is not always favourable for second language learners. First, the language is often exotic, archaic or highly complex, making it only accessible to (highly) advanced learners. Secondly, learners have little control over the presentation of language in often long-winded conversations and cut-scenes, so that they cannot pause, go back, focus on linguistic specificities or request more information. This takes away many opportunities for *noticing*, one of the most fundamental requirements for language acquisition [4]. Thirdly, conversations and descriptions often refer to objects or events that are no longer present at the time of speaking or citing, which at least increases cognitive load, and may even counter the argument that games stimulate situated cognition. Next, many adventure games, and RPGs in particular, have a limited interface for language learning, often in the form of point-and-click dialogues, which requires little, if any, production from the learner. While this kind of interface may be perfect for beginning language learners, who require a lot of (comprehensible) input, this is limiting to more advanced learners. Moreover, the input-oriented reading and writing activities around which these games are centered are a mismatch with the alleged benefit for developing communicative fluency [5]. And finally, the choices which learners have to make in adventure games and RPGs often have little consequence on the narrative, which discredits to a great extent the statement that these games promote learning by discovery. If learners are to learn from (feedback on) the choices they make, e.g. in branched conversations, the choices presented have to be distinct and meaningful [6,7].

Most of these arguments against commercially available adventure games and RPGs, however, can be refuted if the technological frameworks within which these games are developed can be exploited and modified for creating explicitly

educational games. In recent years, adapting existing games and creating new ones has become significantly more feasible. A number of commercially available games such as *The Sims* allow adaptation of the in-game language through third-party customization tools [7]. Further, some game developers, such as the makers of the RPG *Never Winter Nights 2* [8], *The Elder Scrolls* [9] or *Spore Galactic Adventures* [10], release simplified or even full-fledged development toolkits of commercial off-the-shelf games. This allows players to make their own versions (so-called *mods* or modifications) of favoured games, so as to create games with educational content. And, finally, some independent game engines (such as *Unity* [11]) are being released under open-source licenses. As a result, all aspects of game design may become subject to pedagogical requirements, including changes to the (graphical) user interface.

The purpose of this paper is to provide a rationale for treating L2 vocabulary in computer adventure games and RPGs in order to promote the incidental acquisition of vocabulary, and to propose a methodology, both conceptual and architectural, for the adaptation of in-game text on the basis of pedagogy-driven adaptivity. The focus is on incidental acquisition of vocabulary as part of the development of L2 skills, rather than on explicit teaching of L2 vocabulary.

We will first review empirical research on vocabulary acquisition in digital games, and discuss this in light of second language acquisition (SLA) theory. Then, we will look at the research concerning adaptive learning systems. In the next section, we will propose a method for treating vocabulary adaptively in point-and-click style RPGs and put forward a possible software architecture with which to realize the presented approach. We will also discuss some limitations and put forward some methods by which our approach can be evaluated.

2 L2 Vocabulary Acquisition in Digital Games

In adventure games and RPGs, vocabulary learning is incidental, as it inherently forms part of reading, listening or (to a more limited extent) writing practice. Vocabulary instruction in these games, then, is an example of a fully contextualizing technique [12]. Although the pace of vocabulary learning in adventure games and RPGs will be considerably lower than in semi- or decontextualizing techniques, such as rote memorization of word lists, it clearly has some advantages. First, unfamiliar words crop up in a context that might have already activated mental schemata for these new words, allowing for better entrenchment in the memory. Second, concrete lexical items can be presented in auditive and textual or graphical form simultaneously. This stimulates the auditive as well as the visual processing channel, and is hypothesized to improve learning [13]. For textually presented materials, moreover, words may be highlighted in the transcript, so that they may be noticed and become candidates for intake. And finally, the meaning of unknown lexical items can be given when the learner requests it, for instance by clicking on a word presented on the screen or by formulating in writing a request for clarification or simply by repeating the word followed by a question mark. This allows for negotiation of meaning, which is beneficial

for vocabulary acquisition. Negotiation of meaning is not always practical in classroom situations, where large groups may inhibit individualized instruction, and where negotiation might interfere too much with the communication task at hand [14, pp. 64-66].

2.1 Empirical Research on Vocabulary Learning in Games

A handful of studies suggest that adventure games and RPGs may indeed be beneficial for L2 vocabulary acquisition. An experimental study investigated which target language structures in the text-based adventure game *Colossal Adventure* were more likely to be acquired by 84 Chinese-speaking students of English in their first year of higher education [15]. On the basis of the in-game text, three groups of linguistic structures were identified: programme-specific vocabulary (e.g. nouns and verbs which are highly relevant to the game's narrative and flow), prepositions of place, and conditional structures. The study found that learners only improved significantly on programme-specific lexical items. The researchers conjectured that these items were retained better because learners needed to master them in order to make progress in the game, while knowing prepositions of place and conditionals was less crucial, although they too were frequent.

In a second experimental study with 15 English-speaking students of German, a control group read a story in German, while students in the experimental group worked their way through the same story in an interactive text-based adventure format [16]. Students in both conditions of this design-based study were required to afterwards complete homework assignment based on the vocabulary presented in the story, and to write a short essay. Learners who were exposed to the game were found to have stronger established mental schemata of the lexical content and thus better vocabulary retention. Also, it is noteworthy that the students who worked with the print-based materials expressed more confidence in their instructional treatment than the students in the gaming condition.

A small-scale observational study found that 2 beginning Swedish learners of English (aged 9 and 11) improved their vocabulary knowledge by playing a computer adventure game accompanied by L1 translations of target words [17]. Interestingly, on a lexical posttest they restricted all possible meanings of a word that had occurred in the game to meanings that could be related to the game, even if other meanings were equally plausible. This may imply that they had established strong form-meaning links for the words encountered in the game.

Two consistent experimental studies in the simulation game *The Sims* observed that ESL learners who, while playing the game, could rely on supplementary materials such as vocabulary lists, exercises and cultural notes had significantly higher scores on post-treatment vocabulary tests than learners who only played the game [18,19]. Students also found the supplementary materials useful, in particular the vocabulary activities. These findings indicate that adaptation and elaboration of in-game language may facilitate vocabulary acquisition. Even though *The Sims* is not an adventure game or RPG *pur sang*, this observation seems to be applicable to all game genres.

Finally, one study demonstrated that video games may increase extraneous cognitive load, and as such impede vocabulary acquisition [20]. This experimental study examined the effect of interactivity on L2 vocabulary noticing and recall. 80 Japanese students of English were paired based on similar language and game playing proficiency. One student played an English language music video game, while the second student simultaneously watched the game and listened to the auditive cues. Students who only watched the game remembered significantly more vocabulary both on immediate and delayed posttests. The results imply that the kind of interactivity of this game, which was to a large extent based on speed and rhythm, increased extraneous cognitive load, which impedes vocabulary acquisition.

2.2 Discussion in Light of SLA Theory

A theoretical framework that is often quoted in connection with incidental vocabulary learning in games, but which is rarely discussed in detail, is the Involvement Load Hypothesis [21]. This hypothesis states that retention will be higher for vocabulary that is acquired incidentally if the involvement induced by the task is high. The construct of involvement is defined along three dimensions: need, search and evaluation. *Need* is the motivational factor in the construct of task-induced involvement load, and occurs when the learner is urged by some kind of future achievement, e.g. when comprehension of a specific word is required for task completion. *Search* is a cognitive dimension and signifies the attempt to find the meaning of an unknown L2 word or trying to find the L2 word form expressing a concept, e.g. by consulting a dictionary. *Evaluation*, finally, is another cognitive aspect of involvement and is the extent to which a learner has to compare a specific word or word meaning with other words or meanings. These three factors can be simultaneously present in a task and can promote retention. Hence, the challenge is to design tasks that have a high involvement load, and to simultaneously take into account the learner's profile. It makes little sense, for instance, to have a learner evaluate words which are way beyond his or her proficiency level.

The first study summarized above [15] provides some evidence that the involvement load factor *Need* influences L2 vocabulary acquisition in games. Words which are crucial for task (or quest) completion may thus be better retained than words which are not. The dimension *Search* may also be conducive to vocabulary learning in games. Tasks which urge the learner to focus on and query specific formal or semantic features of L2 vocabulary, e.g. by highlighting specific words, or by giving the learners the option to view hidden lexical explanations [18,19], stimulate *noticing* and exhibit a higher search factor than tasks which do not. Research makes it clear that not all kinds of game interactivity can stimulate noticing and search [20]. Finally, adventure games and RPGs can create contexts that display a high factor of *Evaluation*. Text-based adventure games often provide lengthy descriptions of physical objects or events, upon which players have to evaluate which word is appropriate in this context, so that the action may

continue. It is plausible that the presence of this factor results in higher retention in games that stimulate learners to produce vocabulary through retrieval [16]. Also, games seem to stimulate learners to make strong form-meaning connections in the mental lexicon, so that they may exclude other equally plausible meanings for given word forms outside of the gaming context [17].

2.3 Challenges for Language Learning

A first problem with adventure games and RPGs is that they contain a significant amount of text, which players tend to skip because of their lengthiness or complexity. It is advisable that these texts are adapted, so that opportunities for noticing may be created. Secondly, a significant drawback of point-and-click style RPGs for vocabulary acquisition is their limited output practice. Simply clicking on a word and attending to the input does not guarantee that a word will be learned, and being able to guess the meaning from a context does not ensure that the word has been acquired. A measure for checking whether a word is productively known which can be employed in a game is that the learner has to produce it in meaningful contexts, which requires some form of input signal from the learner, either textual or in speech. Finally, games usually provide a certain amount of freedom to the learner, which reduces the chances that learners will encounter the words in the order which the instructional designer has foreseen, or sometimes a learner may even never be exposed to the words which the materials developer had in mind. This calls for careful planning in the development of the learning materials, or it requires run-time planning by an adaptive software component which makes sure that words are presented at the right time in the learning process.

3 Adaptive Learning Systems

Adaptive learning systems are designed to take into account individual differences between learners. At first researchers of artificial intelligence, education and psychology designed Intelligent Tutoring Systems (ITS), substituting a human teacher for an automated interactive tutor while still providing highly personalized instruction. Later it was noticed that tutors taking full control of the learning process somehow restrain the explorative behaviour of the learner, which gave rise to a new type of learning environments that puts more emphasis on learner control [22]. Educational Adaptive Hypermedia Systems (EAHS), named after the hypermedia paradigm of the nineties, stimulate learners to navigate through the learning content and manage their own learning process [23]. Personalization in this approach is mainly to be found in hyperlinks that are automatically personalized based on the learner's knowledge, behaviour and inferred intentions. Although ITS and EAHS inherently start from another point of view on learner control, they share a lot of characteristics. In the following overview, simularities and differences of both approaches are described. Next, a synopsis on existing software technologies for adaptive learning systems is given. In the final subsection, a number of challenges is listed.

3.1 ITS versus EAHS

ITS typically have a very specific focus in terms of knowledge domain and target group so as to allow to provide highly optimized one-to-one instruction. Based on close learning process monitoring, continuous assessment and sometimes even plan recognition they can adjust guidance, support and feedback, which results in highly interactive learning environments. While most ITS research focuses on guidance through and between problems, EAHS try to steer the selection of the next learning topic in the right direction. The learning material in EAHS often consists of standalone text or mediatized pages about a learning topic, which are connected through hyperlinks. In contrast to ITS, which tend to direct the learning process completely, EAHS facilitate learner control by giving navigation recommendations, which stimulates explorative learning behaviour. Some EAHS also adapt the page content to the learner, for instance with conditional text [23]. Adaptivity in both approaches is realized through often hardcoded rules which reflect the instructional strategy and operate on the content metadata as well as on a learner model. The latter holds individual characteristics such as knowledge, learning and cognitive style, affective state, (learning) goals, learning history, behaviour, preferences, and background. As especially knowledge is important, ITS also hold a representation of the target instructional domain (domain model) containing all knowledge elements and their interdependencies. This model together with the learner model serves as input for accurate knowledge tracing which is crucial to provide personalized instruction or learning control. To manage the learner model ITS mostly operate on sophisticated stochastic techniques such as Bayesian Networks [24,25] and Fuzzy Logic [26], while in EAHS implementations tend to be simpler [24] often estimating knowledge based on rules of thumb such as the number of times a topic was visited or the time spent interacting with a topic [27]. Note that this is just a stereotyped comparison. In reality, many systems adopt strengths from both approaches.

3.2 Existing Adaptive Learning Systems

In the last decades many adaptive learning systems have been designed. Especially ITS are plenty in number (e.g. [28,29,30]), but they tend to be focused on concrete cases in a specific instructional domain, which often results in standalone software that limits reusability and integration with other technologies. By contrast, EAHS implementations are often reusable and extendable because of their lower complexity and domain independent nature, such as AHA [27], which offers a versatile open source platform and INSPIRE [31], an adaptive hypermedia framework providing a customizable amount of learner control. Currently, a great deal of technological research in adaptive learning focuses on the design of generic adaptive learning system architectures, thereby trying to integrate and stimulate reuse of different technologies and educational methodologies. In the literature, a shift may be noticed from architectures focusing on once-only personalized retrieval and recommendations of educational content (e.g. [32,33]), towards more complex architectures combining ITS and EAHS

principles for steering and guiding the learning process either from a more global level, e.g. the GRAPPLE project [34] or from more nearby, e.g. [35,36,37,38].

3.3 Challenges for Adaptive Learning Systems

The literature suggests that combining the strengths of both ITS and EAHS can result in very effective learning environments [35,39]. However, despite decades of inter-disciplinary research on adaptive learning systems, most implementations stayed in a prototype phase. We believe one of the reasons for this is the lack of clearly identified ready-to-use adaptivity strategies. Although for some content types possible adaptations have been identified (e.g. [23] for web based), educational content exists in many other different shapes (e.g. mini-games, plain text, ...) and each time targets a very specific instructional domain, resulting in many different potential adaptations and adaptivity strategies. Therefore, we think it is useful to formally look for and identify different types of adaptations of a particular content shape, to develop instructional strategies which steer these adaptations and to test these strategies by performing evaluation studies in the instructional context they are designed for.

4 A Method for Treating Vocabulary in Adventure Games and RPGs

The objective of this design proposal is to provide a mechanism for treating L2 vocabulary incidentally in point-and-click style adventure games and RPGs that contain an orthographic transcription of the game's conversations. The use case described below mainly focuses on the aspect of *noticing*. Even though it may be argued that a lot of L2 acquisition in games happens implicitly, it is generally accepted in the SLA literature that a certain amount of (explicit) attention to formal aspects of an L2 is required, so that new (word) forms may be noticed by learners, and become candidates for intake [40]. Still, it seems important that the player should not feel disturbed by information not asked for or by information that draws him away from playing the game. For this reason, we would like to inject into the game-playing experience short periods that allow (but don't compel) the learner to focus on formal aspects of an L2 while he or she attends to the meaning of the language that emerges from the game.

4.1 Use case

In point-and-click adventure games and RPGs, the game typically consists of a number of quests which the player has to complete. In order to obtain information on these quests, the player('s) character (PC) has to engage in conversation with non-player characters (NPCs). The player is presented with a series of utterances spoken by the NPC, each of which is followed by a number of options which the player can click. When clicked, such an option becomes a response from the PC to the NPC. Each response leads to a reply from the NPC. In

this way, a pre-programmed tree of PC and NPC utterances is translated into a linear dialogue with a reasonable amount of choice and freedom for the player.

We propose to exploit this mechanism of choice for having the L2 learner request more information on difficult, unknown or domain-specific words in the NPC utterance. For each such a word in an NPC's utterance, an option is added to the list of PC options (e.g. "What do you mean by WORD X?") which, when clicked, leads to a short but natural explanation of that word, spoken by the NPC (e.g. "Well, WORD X is when you ...") (see Fig. 1). This way of explaining words is e.g. to be found in the COBUILD monolingual learner's dictionary [41].

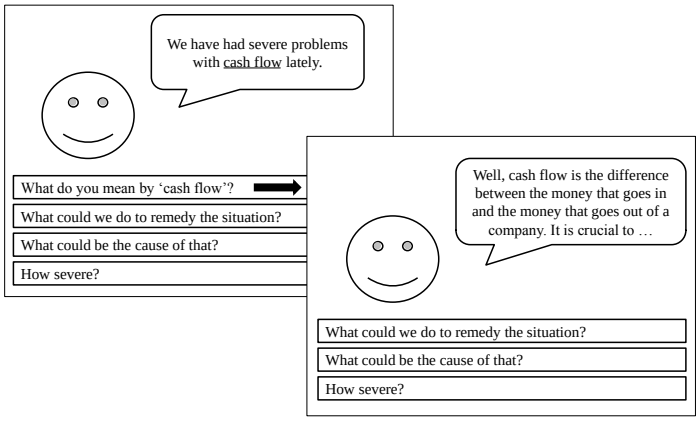

Fig. 1. Mockup showing help option for vocabulary in a conversation with an NPC, and subsequent elaborated input.

The proposed technique is of course very similar to glossing words in a reading text, but it is interwoven with the game-playing experience. Moreover, by having an NPC give the explanation of a specific word, rather than a pop-up dictionary, these explanations are examples of what has become known as *elaboration*, i.e. the ways in which native speakers (NSs) modify their discourse in order to make it comprehensible for non-native speakers (NNSs). Elaborations also occur very frequently in teacher-learner and learner-learner talk, and are highly valued in communicative language teaching methods because they focus on the communicative task rather than on the L2. In natural communication, elaboration typically occurs during an interaction known as *negotiation of meaning*, when NSs and NNs (or L2 learners) are focused on achieving communication while working together on a task. An increasing number of studies suggest that negotiation of lexical content leads to more learning than learning without negotiation [14, pp. 64-65]. Evidently, for L2 learning, negotiated elaboration of L2 word forms is superior to lexical simplification, because the new words are not removed from authentic texts. Negotiated elaboration has become a central

component in task-based approaches to language teaching, and pleas have been made for including them in e-learning contexts as well [42].

In addition to inserting an option for each word in a L2 dictionary, words which are assumed to be rather difficult for the learner given his or her current vocabulary proficiency level can be highlighted in the NPC utterance (e.g. in a bold font), in order to increase the chances of 'noticing', which is the starting point for language acquisition. A starting point for a reasonable estimation of lexical difficulty is word frequency. Frequency counts on the basis of large corpora can classify words in frequency bands. Normally the first band of most frequent words of a particular language consists of function words and a limited set of common content words, which allow to understand most of a text. Lower frequency bands contain less widely used words, and more specialised vocabulary. These frequency bands can then be related to learner proficiency on a probabilistic basis. If a learner knows most of the words in a certain frequency band, then he or she can be understood to have a vocabulary proficiency related to that frequency band.

Obviously, the limited nature of the learner's interaction with the game's text (i.e. through point and click) prevents measuring lexical knowledge reliably, because tracking clicks is a measure of learner behaviour and not knowledge, but this knowledge can be dynamically assessed in the game at least in a partial way. If a learner requests the meaning of a word which he or she is supposed to know (on the basis of probabilistic estimations of the learner's vocabulary proficiency), then the action of clicking might imply a lack of knowledge of that lexical level, and the level of the learner may be adjusted downwards. E.g. if the learner has proficiency level x, and he or she clicks on a vocabulary item in the frequency band x-3, then the probability of the learner having level x may be decreased, and the probability of him or her having level x-3 can be increased. The learner may then be redirected to educational activities outside of the game (e.g. in a learning management system) or inside the game (in the case of an educational game containing activities designed for learning). In a learning management system, this can be done through traditional vocabulary exercises which are assessed ; in an educational game, a meaningful side-quest can be presented in which the learner must decide in a conversation with an NPC upon the meaning of a word, or upon the specific form for a given word meaning. When the learner re-enters the main game quest, vocabulary items will be highlighted in accordance with his or her adjusted proficiency level.

4.2 System Architecture

In the following section, we will outline a high level system architecture for implementing the use case. Our technique of adapted utterances in conversation turns provides a personalized way of learning support, while still leaving full control to the learner. In this way, it bears a large resemblance with the individualized recommendations in EAHS, but we will use a specific methodology to construct the learner model. We will entrust the proposed technique to an external learning system service, which is dedicated to the adaptation of the clickable

options in a conversation turn. This service will pass on the required educational adaptations to the game through an API provided by the game, and will rely on other services of the learning system (e.g. assessment service) in order to get information based on which it can tune the utterances of a conversation turn to the learner and the game situation. For the realization of our adaptive technique we will employ the architecture pictured in Fig. 2. The learning system on the right-hand side of the architecture contains a database and implements some services: a logging service, a conversation adaptation service, a vocabulary exercise service, and an assessment service. The game client is equipped with an API through which conversation turns can be adapted on the basis of content external to the game, an API through which additional vocabulary exercises can be sent to the game, and a logger which will inform the learning system logging service at run-time about what happens in the game (e.g. what support was asked for).

For the use case described above, the learning system database needs to keep four types of information. First of all, a representation of each conversation turn in the game is needed, in which all present words or linguistic expressions are described. We assume this information is generated beforehand, but the process of obtaining the conversation turns and preprocessing them could also be done at run-time. Secondly, it will contain information on the vocabulary domain to be learned. Next to the L2 dictionary, it will keep estimations on difficulty (based on frequency counts) for each lexical item. Thirdly, it contains a representation of the current knowledge of the learners. We will use knowledge estimations for each vocabulary domain complemented with reliability parameters, which can be interpreted through Item Response Theory (IRT [43], a Bayesian network like technique) by involving levels of difficulty for the words of the vocabulary domain. Additonally, we will also keep a collection of vocabulary exercises which can be launched in the game when there are indications that the learner's learning process gets stuck or when detailed assessment is required. When the player starts a specific conversation in the game, the Conversation Adaptation Service will adapt that conversation to the vocabulary proficiency level of the learner. This conversation will then be passed back to the game through the Conversation Adaptation API. The adaptivity strategy behind this personalization will be interchangeable and will decide on (1) which utterances will be added to each conversation turn, (2) which words in each utterance will be highlighted and how (e.g. italic, bold, coloured etc.), and (3) it will compose the exact elaborated input which the NPC should return in case the learner clicks on an utterance asking for support. The Assessment Service keeps a one-dimensional estimate of the learner's knowledge for each vocabulary domain (e.g. business English, nursing etc.) in a way conformable to IRT. Information on the frequency bands and the number of times help has been requested for each lexical item will be stored and will serve as input for heuristics which will adjust the estimations of knowledge (as explained in 1). As stated earlier, we don't expect interactions with the point-and-click dialogue system to lead to knowledge estimations, but only to contribute to them. Therefore, to keep an accurate account of a learner's

knowledge level, the Vocabulary Exercise Service will be used which will once in a while redirect the learner to easily assessable vocabulary exercises in unobtrusive windows on top of the game scene. Hereby we assume there is a mechanism in the game to pop up a series of sequential vocabulary exercises (e.g. in Flash), which can be operated through an API of the game, here called Pop-up Excercise API.

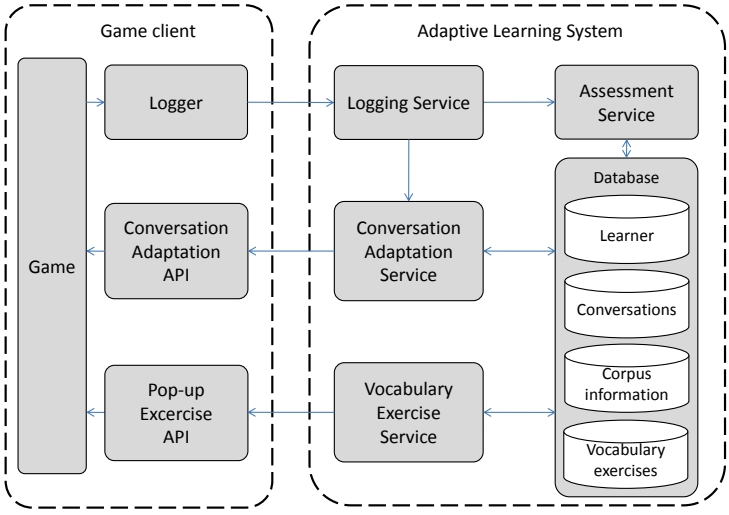

Fig. 2. System architecture realizing the adaptations

Our approach is in accordance with the generic architectures for centralized adaptive learning systems discussed in 3.2, and adopts their advantages. First, our service providing adapted conversation turns can easily make use of existing assessment and management services of the learning system thereby increasing quality, integration and maintainability, and facilitating the development of the service. Secondly, it enables the reuse of the service's implementation with renewed RPG versions or even with other RPGs, at least if the latter implement the required API. Alternatively, we could embed the adaptivity logic in the game by making use of game specific tools or frameworks (e.g. scripting code), but that would hinder the reuse of our implementation. Compromise solutions include automatic generation of scripting code based on game independent adaptivity logic, but this method increases development and maintenance costs as scripting languages often change and most games require different generators. Third, putting the decision making process on educational adaptations in a dedicated learning environment outside of the game allows new educational adaptive strategies to be tested and implemented very efficiently, and can ignore the specificities of implementation on the game client. Finally, our approach allows easy integration of

existing educational services, such as the included Vocabulary Exercise Service, which could make use of existing software offering traditional (e.g. web-based) learning objects.

4.3 Limitations

A number of limitations to this approach must be noted. First, if it were to be applied to commercial games, this technique will probably only work with advanced learners. It is suggested that vocabulary can be treated incidentally if at least 95 % is known of the running words in the input a learner is focusing on [14]. Thus, a detailed lexical analysis of a commercial game's text is first of all required. Second, it is important to know that elaboration alone will most likely not account for all learning. A blend of several vocabulary instruction techniques is required, even if the focus is on meaningful communicative tasks [14, p. 65]. Third, this technique can only be applied to NPC utterances, as it would be awkward if a player requested the meaning of a word which his PC utters himself. However, it is to be expected that most of the new words are spoken by NPCs, since it is generally they who present the learner (the PC) with new contexts and assignments. Next, the presented approach assumes game conversation turns to be adaptable at run-time. This presupposes the presence of a game API, which may be hard to put in place since most commercial games do not offer such way of external control. Finally, until now, we have assumed elaborations of PCs and NPCs to consist only of transcriptions. However, if the utterances provided by the game are also spoken, then the elaborations require a corresponding auditive representation. To this end, one can fix all possible vocabulary elaborations and record them in advance, but this would take a lot of time and so would be a burden to the development of content. Alternatively, one can use text-to-speech software to dynamically create the speech.

4.4 Evaluation

Several aspects of our proposal can be evaluated. First, we will optimize our initial implementation by some small-scale experiments. Thereby, we will fix what words will be highlighted and how, and we will optimize the presented assessment techniques especially ensuring that the heuristics which adjust the knowledge level converge well. Once the architecture is up and running, we can perform experimental studies to answer various research questions some of which are discussed below. The logging data resulting from these experiments can also be employed to fine-tune the assessment service afterwards.

If the objective is to evaluate whether the lexical elaborations provided by the NPCs lead to more vocabulary learning, a study can be set up with one experimental condition in which learners have the option to request lexical help, and a control condition in which the learners just play the game. However, it is very likely and somewhat evident that learners who get help will learn more vocabulary, as previous studies have demonstrated [18,19].

More interesting would be to compare two experimental conditions, one of which provides optional elaborations, while the other one forces learners to request the elaborations, e.g. by inserting a separate player turn containing only help options for the next turn, rather than showing the help options together with the other options for the PC. As one study has shown before, mandatory usage of lexical help will lead to more learning [18], but in the context of gaming this might compromise the playing experience.

What could also be evaluated is whether highlighting novel words in the NPC utterances leads to more requests for help, and whether this correlates with vocabulary learning. As a previous study in a hypertext environment has pointed out, language learners tend to demonstrate less conscious and less focused clicking (so-called 'happy clicking') when links are made more visible or salient [44]. Point-and-click conversations in games seem particularly apt to stimulate such a behaviour, especially in RPGs, where players might be eager to get to their next exploration or combat phase as quickly as possible.

5 Conclusion

In this paper, we introduced a mechanism for increasing the chances of noticing vocabulary in dialogue-based RPGs or adventure games. A game player who is not familiar with a word uttered by his virtual conversation partner can request an elaboration of that word which will subsequently be provided by the computer character. We reviewed the literature on vocabulary acquisition in digital games in the light of second language acquisition, and situated our technique in this context. We also outlined the relevant research concerning adaptive learning systems, and observed a trend towards centralized learning system architectures. For the realization of our proposal, we put forward and explained such an architecture. Finally, we pointed at some limitations, and listed methods by which our approach can be evaluated.

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