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Article

ULearnEnglish: an open ubiquitous system for assisting in the English vocabulary learning

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Abstract: Language learners often face communication problems when they need to express themselves and do not have this ability. On the other hand, continuous advances in technology create new opportunities to improve second language (L2) acquisition through context-aware ubiquitous learning (CAUL) technology. Since vocabulary is the foundation of all language acquisition, this article presents the ULearnEnglish, an open-source system to allow ubiquitous English learning focused on incidental vocabulary acquisition. To evaluate the proposal, 15 learners used the system developed, and 10 answered a survey based on the Technology Acceptance Model (TAM). Results indicate a favorable response to the use of the learner context to assist them in their learning. The ULearnEnglish achieved an acceptance of 78.66% for the perception of the utility, 96% for the perception of ease of use, 86% for user context assessment, and 88% for ubiquity. This study presented a positive response in using the location of users to assist their learning. Among the main contributions, this study demonstrates an opportunity for ubiquity use in future research in language learning. Also, furthers studies can use the source available to evolve the model and system.

Keywords: English vocabulary learning, Incidental vocabulary acquisition, Context-aware ubiquitous learning, Ubiquitous Computing, Open-source software

1. Introduction

The survey conducted by Council [1] points out that only 5.1% of the Brazilian population aged 16 years or older claims to have some knowledge of the English language. A low rate, even though the English foreign language is defined as mandatory from the sixth year of elementary school, according to the common national curriculum base of Brazilian education [2]. Second language students often fail to express exactly the intended message due to a lack of knowledge of the vocabulary of the target language. Noticing the gaps in vocabulary facilitates incidental word learning from information received from the learner's environment [3].

Today, learning a new language is no longer limited to traditional classroom settings [4]. The increasing use of technology has changed the way English is learned and taught [5],[6],[7]. Mobile and ubiquitous technologies expand the possibilities of learning a language by allowing access in multiple contexts [8], [9]. Thus, by providing access to a set of resources and tools, these technologies offer significant advantages when promoting second language learning [10].

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Open-source software constitutes a strategic methodology for the collaborative development of software in different areas of knowledge. Learning environments have explored this approach [11] in themes such as the development of technology in final degree projects [12], improvement of learning programming [13],[14] impact of the use of this strategy in companies [15], improvement of the use of Java in learning [16] and the use of drones to support distance learning [17].

This paper proposes ULearnEnglish, a ubiquitous and open learning system to aid the teaching of English language vocabulary. The scientific contribution consists of using context awareness [18] and incidental technique for vocabulary acquisition [19]. Studies that focus on mobile device-assisted vocabulary acquisition have been shown to be quite effective. Hao et al. [20] mentioned that students using cell phones to learn English vocabulary learn more words than learning through other media. Also, Chen et al. [21] confirmed that incidental vocabulary acquisition contributes to the engagement and also retainment of the new words learned.

In addition to developing grammar and vocabulary, language learners need to develop a willingness to pay attention to the cultural connections between forms, contexts, and meanings [22]. Therefore, the advantage of using ubiquitous learning is to bring new approaches to studies, especially regarding the possibilities of personalizing according to the context and profile of the learner [23].

This paper is organized into 7 sections. Section 2 approaches topics related to this work, allowing a background to assist the understanding of the proposal. Section 3 presents the works related to ULearnEnglish. Section 4 details the research methods used. The proposed model solution is presented in section 5, and section 6 presents and discusses the evaluation results. Finally, section 7 approaches the conclusions.

2. Background

This section aims to describe concepts related to the importance of vocabulary in learning a new language and how ubiquity learning can assist in this context.

2.1. Vocabulary acquisition strategies

Vocabulary acquisition strategies are mainly categorized into two types: incidental and intentional [24]. Instead of intentionally acquiring words, incidental learning refers to acquiring new words in a context without necessarily looking for them [24]. Learning intentionally can reduce motivation by forcing whoever is learning to focus on certain aspects of word knowledge [19].

The knowledge of a word is built through several expositions to it. Users need to perceive words from their environment whose meanings they do not know. They need to become aware and explore the relationship between words to perfect and fully develop the meaning [25]. Vocabulary acquisition facilitates the development of other language skills, such as listening, speaking, reading, and writing [19].

An effective way to learn something new, mainly concerning knowledge in the long term, is learning through memory [26]. From memory, a person can elaborate knowledge, make relationships and associations between facts, make inferences, reproduce information and experiences. The use of memory is critical in the learning process and teaching, especially about teaching a foreign language [27].

Learning strategies using memory can be essential to adult learners since frequent exposure to the language increases the learning process. Current memory techniques may involve repetition or mnemonics use, as suggested by Cohen et al. [27].

2.2. Context-aware ubiquitous learning

Learning strategies and technologies have evolved together, helping each other to advance in their specific knowledge and integration. In this sense, mobile and ubiquitous technologies have fostered learning strategies through the creation of mobile learning (m-learning) [28],[29],[30] and ubiquitous learning (u-learning) [31],[32],[33].

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M-learning is an evolution of e-learning that allows students to carry learning environments on their mobile devices. On the other hand, U-learning considers the integration of mobile devices, sensors, wireless communication, location/tracking mechanisms, and several other technologies to create learning environments based on context-aware computing [34] and ubiquitous computing [35]. This context-aware ubiquitous (CAUL) technologies provide a learning platform that allows continuous language learning, more interactive and context awareness, that can happen anytime, anywhere [36].

Recently, ubiquitous computing has been empowered with the use of temporal series of contexts to organize and analyze the data. This new research area received the name of Context Histories [37],[38],[39],[40] or Trails [41],[42]. This kind of data organization allows the exploration of advance strategies to data analysis, such as, profile management [43],[44],[45],[46],[47], pattern analysis [48], context prediction [49] and similarity analysis [50],[51]. All these strategies allowed the use of Learning Analytics [52],[53]. In this scenario, Ubiquitous computing and consequently ubiquitous learning encourage the collaborative development of contents and knowledge [54],[55], allowing a strategic platform for the use of open source software both for its development and for the development of other technological platforms based on open-source strategies.

A ubiquitous learning environment is any scenario in which the user can become immersed in the learning process [56]. For instance, while the user moves with a mobile device, the system dynamically supports the learning process through communication integrated with the environment. In this sense, cameras allow to use the tracking in the environments to support the learning [57]. The study, based on user preferences, was carried out by Cohen et al. [56], states that u-learning systems should not force the learner to follow the content established by default. The essence of u-learning is to realize which information is presented in the user's daily tasks in different forms and places and use it for learning purposes.

Researches in u-learning have been demonstrating relevant results. Through an integrated network, the study carried out for Mouri et al. [58] allowed students to record what they had learned with the help of using media and sensor data. Such integration helped students understand the relationships between knowledge, location, and time. Also, the study of Wang et al. [59], which analyzed the use of ubiquity applied to teaching in museums, demonstrated that students have moved from passive receives content to active learners with the use of ubiquitous tools. Through such examples, it is understood that integrating systems with social and user location contexts has been effective for learning. Cardenas and Pena [9] carried out a systematic review of ubiquitous learning, allowing an overview of this area of research.

3. Related Works

Chen et al. [21] brought the idea of the use of video games to help in vocabulary learning. They developed an adventure game with two versions, one with the game and the other with the vocabulary exercises based on the game. They conducted an experiment to evaluate the game. The results showed that learners that used the second version of the game with the vocabulary exercises retained more new words. As the ULearnEnglish, this study also applied the strategy of incidental vocabulary acquisition. However, the ULearnEnglish uses the learner's day-to-day routine context to get new words and vocabulary, providing more opportunities to learn something new every day.

Ginn et al. [36] presented a mobile vocabulary learning application that integrates real-time object recognition and label translation. The authors used a framework consisting of three processes in recalling vocabulary: noticing a word, retrieval of the word from memory, and creative use or generative use of the word in the learner context. The study brings the use of artificial intelligence techniques, such as real-time object detection, and immediate feedback. However, this study still is in the conceptual model stage.

Hao et al. [20] used cognitive learning as a pedagogical approach for English vocabulary acquisition. The authors developed a game for mobile devices (Android and

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smartphone) with missions that need to be performed by students. Unlike this model, the pedagogical approach used by ULearnEnglish is the incidental vocabulary acquisition technique [19], since incidental vocabulary acquisition strategies assist in learner motivation.

Purgina et al. [22] developed a grammar learning model based on a natural language learning technique. The model allows for the configuration of the language to be learned. Teachers must do this task by teachers by means of a configuration of the learning content in XML. Due to usability issues and a pedagogical approach, the model was developed only for Tablets and PCs. The authors also mention the use of gamification elements to support learner engagement.

Wang et al. [8] developed a model of ubiquitous learning based on the use of learner context. However, unlike ULearnEnglish, these works used a specific context for learning specific content. The content could be accessed by learners using their smartphone and reading a QR code, available at the learning location. In ULearnEnglish the learning context is independent and personalized, configurations can be made for the learning context and content. Table 1 presents a comparison of works related to the proposed model, highlighting the relevant criteria considered for the development of ULearnEnglish.

Table 1 shows that ULearnEnglish differs from other works mainly in the use of the learner's context, which can be configurable and personalized, an important characteristic of ubiquitous learning; and design science research (DSR), the research method adopted.

4. Research Method

The present study adopted design science research (DSR) [60] as the research method. This method enables the construction of a wide range of sociotechnical artifacts, such as the ubiquitous learning model proposed in this research. DSR allows to solve research problems more effectively and efficiently and to make real and practical contributions. Thus, this work followed the steps proposed by Kuechler and Vaishnavi [61] to conduct the DSR, as presented in Figure 1.

The first step of the DSR consists of the awareness of the research problem. This step followed these procedures: (1) hypothesis definition of the research problem that users' contexts can assist in their learning of English vocabulary, (2) literature review, exploring the teaching approach that the application could cover, such as incidental learning and English for specific purposes, (3) interview with two Ph.D. professors who work as English language teachers in a University. The contact with the professors was done more than once and allowed to validate the hypothesis and the elaboration of an instrument (questionnaire) to be applied at a later step.

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Table 1: Comparison of related works

Criterias	Chen et al. [21]	Ginn et al. [36]	Hao et al. [20]	Purgina et al. [22]	Wang et al. [8]	ULearnEnglish
Second Language Acquisition	Yes	Yes	Yes	Yes	Yes	Yes
Focus on learning	Vocabulary	Vocabulary	Vocabulary	Grammar	Reading and Listening	Vocabulary
Second language in focus	English	Customizable	English	Customizable	English	English
Pedagogical Approach	Incidental technique for vocabulary acquisition	Recalling vocabulary acquisition	Cognitive learning	Natural language grammar acquisition technique	Language learning for specific purposes	Incidental technique for vocabulary acquisition
Mobile app type	Video game native app	Native app	Native app	Native app for tablets	No details	Web-based app
Operating Systems	iOS	Android	Android	Android	No details	iOS and Android
Using the context of learner	No	Yes, object recognition	No	No	Yes, specific context	Yes, configurable context
Use of Gamification	Yes	Yes	Yes	Yes	Yes	No
Research method	Experiment	The app is a conceptual model	Quasi-experiment	Classroom experiment	Experiment	DSR
Audience target	College students	Apprenti-ces in general	Apprenti-ces in general	Teachers and students	Apprenti-ces in general	Apprenti-ces in general
Evaluated the application	Yes	No	Yes	Yes	Yes	Yes
TAM evaluation	No	No	No	Yes	No	Yes

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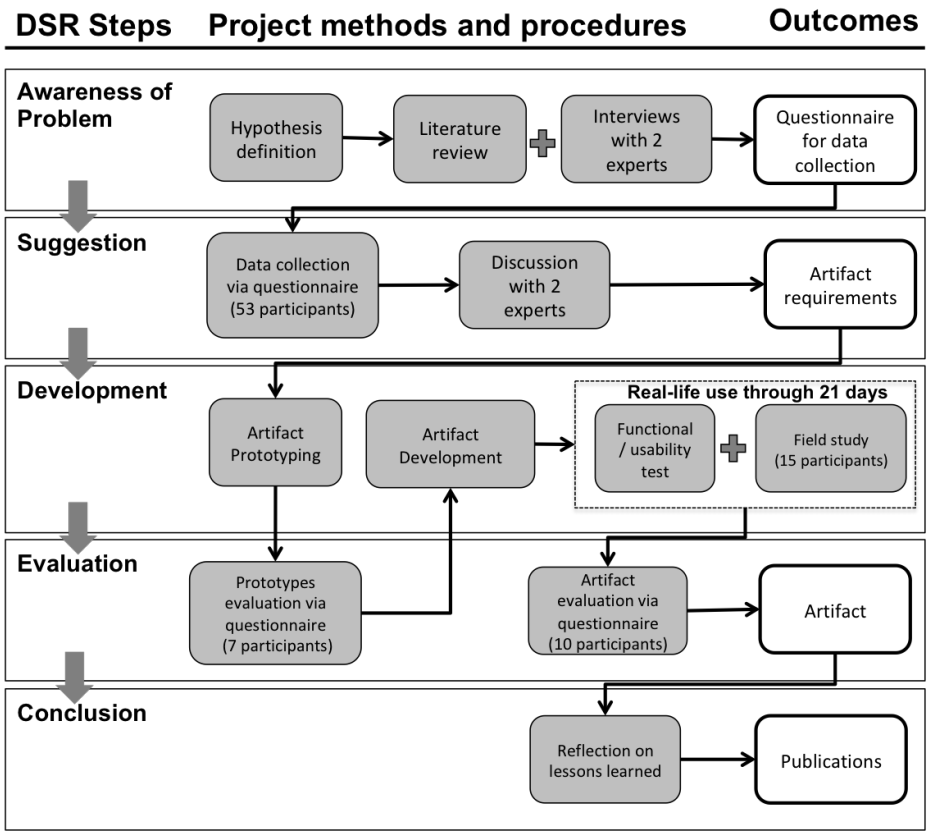

Figure 1. DSR Steps.

The second step of the DSR (suggestion) consists of applying the elaborated questionnaire in the first step to deepen the understanding of the problem with potential ULearnEnglish users. This collection allows identifying the real needs of users that should be addressed by the ULearnEnglish artifact. The questionnaire was operationalized through Google Forms and obtained 53 answers.

Based on the results of the second step, the requirements of the artifact were defined, and the third step of the DSR began. This step started with the prototyping of the artifact instance. The prototypes were generated for iOS and Android operating systems, and their prototypes images were attached to a questionnaire for a first evaluation, mainly related to the usability evaluation. In the questionnaire, respondents were asked to evaluate the screens regarding their perception of usability, usefulness, and understanding of the application. The questionnaire was operationalized through Google Forms, obtaining a return of 7 participants. After the prototype evaluation, started the development of the ULearnEnglish. Two procedures allowed the evaluation of the system: (1) the mobile application was installed and used by 15 users for 21 days, (2) from these users 10 of them answered a questionnaire after trying the system.

Table 2 shows the relationship of the questionnaire statements with the evaluated aspects and presented statements elaborated based on the concepts of the Technology Acceptance Model (TAM) [62], originally proposed by Davis in 1989 [63] and adapted by Chang, Yan, and Tseng [64], for the acceptance of mobile technology applied to English learning. This adapted TAM model considers the following aspects for the user to accept a given technology: perceived usefulness (PU), perceived ease of use (PEOU), perceived ubiquity value (PUV), and context (C).

5. ULearnEnglish System

This section presents the proposed system. Initially, the overview of the model is illustrated, followed by the description of the identified requirements. Finally, the details of

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Table 2: Statements and aspects applied to evaluate the ULearnEnglish

	Statements	Aspect
1	The ULearnEnglish application has helped me learn and/or reinforce my understanding/study/ learning of inglish.	Yes
2	Repetition of a content helped me to record it more easily.	PU
3	The app's notifications have encouraged me to use it more often.	PU
4	The application was easy to use without the need for help.	PU
5	I was able to use the application satisfactorily.	PEOU
6	The application correctly found the locations near me.	PEOU
7	Seeing content with the location near me encouraged me to use the app more often.	C
8	The application respected my preferences when displaying the contents.	C
9	The use of pictures and examples helped me memorize the content.	C
10	The information brought from places near me, made sense referring to the place where it was presented	PUV

the developed mobile application, the instance of the constructed artifact, and the aspects used for the identification of the user context are presented.

5.1. System Overview

The creation of ULearnEnglish followed the principles for the development of a CAULL (Context-aware ubiquitous language learning) model. The system is intended to support the acquisition of English vocabulary according to the user's context. As a pedagogical approach, the model makes use of incidental vocabulary learning. This learning refers to the acquisition of new words in a context without necessarily the learner having looked for it [19]. This context is observed through the resources available on the users' mobile devices.

The learning content data is stored in a relational database. The data exchange between the web server and the application is done through files in JSON (JavaScript Object Notation) format. For obtaining the users' locations through their geographic coordinates, the application consumes data from the Google Places API (Application Programming Interface). Figure 2 illustrates an overview of the system and the interaction between these components.

ULearnEngilsh was developed based on the MVC (Model - View - Controller) design pattern. The fundamental principle of this pattern is the division of the application into three interconnected layers in order to separate the presentation and user interaction with the application, the internal controls of the system logic, and the data handling [65].

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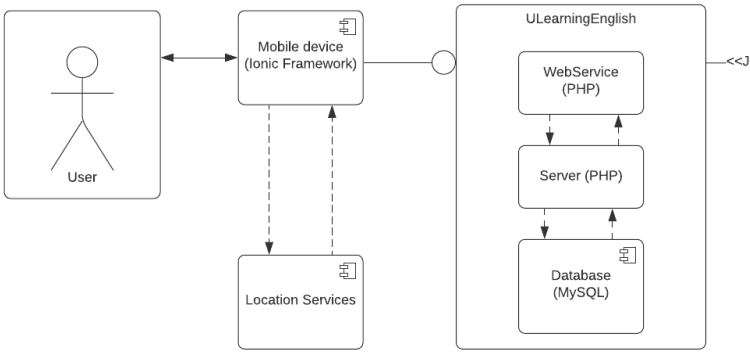


Figures - Architecture model.png

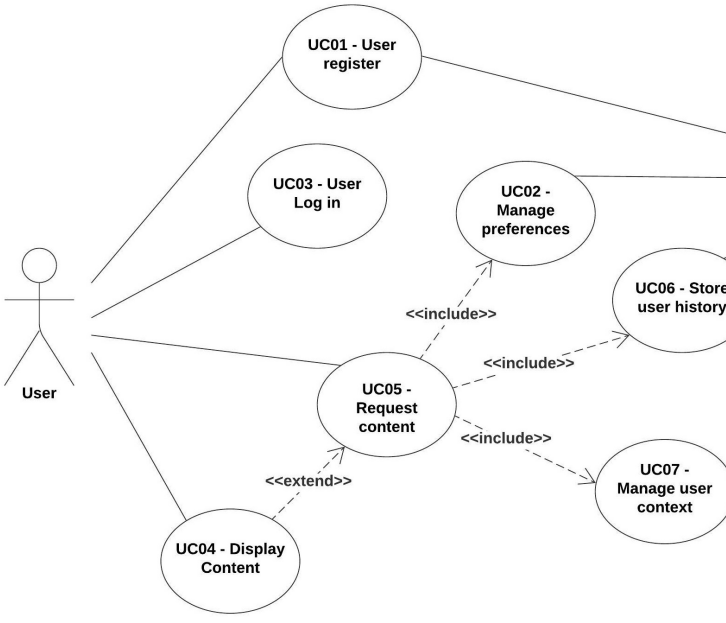
Figure 2. ULearnEnglish system overview

5.2. System Requirements

From the results of the first and second stages of the DSR (Figure 1), the requirements that the ULearnEnglish model should cover have been identified. Figure 3 shows the use case with the functional requirements.

The user must be registered and logged in (UC03), to gain access to the contents of the application. In their first contact with the system, users perform the registration (UC01) for access. After this step, users are redirected to manage their preferences (UC02), which can be changed at any time later. Once the previous steps are completed, the system obtains the user's geographic position to send the web server the content request according to the user's location and profile settings (UC07).

The web server, in turn, returns the contents to be displayed (UC04) and stores the history of the contents displayed per location (UC06). The user has access to the daily history briefly. Also, once the contents brought by the web server are over, the user has the option to request other contents (UC05).



Figures - Use case diagram (1).jpeg

Figure 3. ULearnEnglish Requirements

5.3. Implementation aspects

The system was instantiated and later evaluated by means of a mobile application developed using the Ionic framework. This framework was chosen because it allows the creation of hybrid applications (Web-based app) for use on mobile devices with iOS or

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Android. Figure 4 shows three screens of the mobile application, corresponding to the use cases UC03, UC04, and UC06, discussed in the previous section.

Image 2017-09-29 at 10.23.45.jpeg

Figure 4. Mobile Application Screenshots

For user context management, the mobile application uses Ionic's native Background Geolocation plugin as a mechanism to control the user's position. The plugin monitors a certain radius, and in case of displacement, changes the geolocation variables. The user's position is passed to the Google Places API by requesting the NearBySearch method. The request returns a JSON file with information about places near the user within a parameterized radius.

For each location found in the vicinity, the JSON returns information about it. Figure 5 highlights the main information used by the application which are the name of the place (name), address (vicinity), and type of place (types). It is through the information contained in Types that the application requests context-based content from the webserver.


```
"name" : "Academia Companhia do Corpo",
"opening_hours" : {
   "open_now" : true,
   "weekday_text" : []
},
"photos" : [
   {
],
"place_id" : "ChIJfymoa6VDGZURdcNqYMM1fxc",
"rating" : 4.6,
"reference" : "CmRRAAAAx3Mg_qCUMyrDBjedrWct-pb-CpOG15ojIzXbuqhDUjoMRMLODhBvmp6-gHylQxp
"scope" : "GOOGLE",
"types" : [ "gym", "health", "point_of_interest", "establishment" ],
"vicinity" : "Rua Júlio de Castilhos, 246 - Centro"
,
```


Figure 5. NearBySearch return from a location near the user

Table 3 shows the 19 types of places used in the evaluation. These places guided the learning content which was obtained through the Google Places API return list. Through these places, the web service performs the database search for the learning content related to the user's context. In addition, the user's preference by the incidence of the content type is evaluated among general vocabulary, verbs, and phrases. The types of locations were chosen by running the API in geographic coordinates tests, verifying possible returns, and by the context diversity criterion.

6. Analysis and Discussion of Results

This section presents and discusses the results obtained in the ULearnEnglish evaluation.

6.1. ULearnEnglish Data Evaluation

Table 3 shows that 240 contents were registered, distributed in 19 types of locations, where content could appear in more than one location according to its context. Among the types of locations, it was found that two of them had no users nearby: airport and bus stop. Therefore, the contents registered for these locations were not displayed. The locations that had the highest incidence for users were related to commerce - clothing stores - and food as restaurants.

6.2. Model Acceptance Evaluation

The evaluation was conducted with participants who made use of Android devices. Participants in the second stage of the DSR were invited to use the mobile application and then answer an evaluation questionnaire. Fifteen users made use of the application, and 10

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Table 3: Analysis of contents by site type

Type of Location	Number of contents per site				History		Average Appearance (5)/(4)
	Vocabulary (1)	Verbs (2)	Phrases (3)	TOTAL (4) = 1+2+3	User Appearance (5)	% appearance((5)/(4)	
Academy	1	21	17	47	200	4,616	4,26
Airport	11	11	16	36	0	0,000	0,00
Bank	18	10	17	45	429	9,905	9,53
Bar	17	18	28	63	20	0,462	0,32
Nightclub	11	12	23	46	0	0,000	0,00
Food	19	16	22	57	541	12,491	9,49
School	19	20	30	69	441	10,182	6,39
Pharmacy	22	7	16	45	37	0,854	0,82
Hospital	18	12	20	50	231	5,334	4,62
Real estate agency	11	7	10	28	112	2,586	4,00
Furniture Store	14	6	20	40	79	1,824	1,98
Clothing store	18	11	21	50	921	21,265	18,42
Bakery	19	13	16	48	8	0,185	0,17
Bus stop	4	15	12	31	0	0,000	0,00
Restaurant	24	18	24	66	540	12,468	8,18
Beauty parlor	10	4	3	17	27	0,623	1,59
Health	13	11	13	37	547	12,630	14,78
Shopping Mall	25	14	34	73	28	0,647	0,38
University	23	21	29	73	170	3,925	2,33

completed the questionnaire. The profile of the participants was nine men and one woman between the ages of 16 and 35. Figure 6 presents the responses.

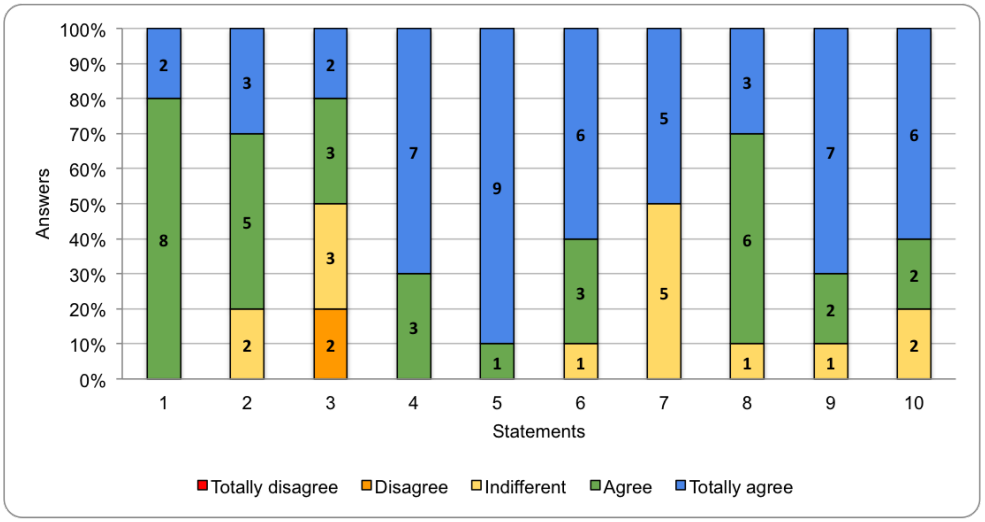

Figure 6. TAM evaluation results

Following the same procedure performed by Chang, Yan, and Tseng [64], all values of the proposed scale of the statements corresponding to the aspect of TAM [64] were

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Table 4: Aspect evaluation

Questions	Formula	Result
1,2,3	∑ (1,2,3) (5103)	0,7866
4,5	∑(4,5) (5102)	0,9600
6,7,8,9	∑(6,7,8,9) (5104)	0,8650
10	∑(10) (5101)	0,8800

summed, and the result was divided by: 5 (highest value of the scale) * No. of Interviewees (10) * Number of questions, according to Table 4.

The perception of usefulness (corresponding to statements 1, 2, and 3) obtained a degree of agreement of 78.66%, where the greatest divergence of opinion of users is in the perception of usefulness for the use of notifications in the application. The usefulness aspect was also described by users as "quite useful both for those who travel abroad and for those who come" (Participant ID02) and "very interesting idea to stimulate the learning of a new language" (Participant ID09).

The result of the perception of ease of use (corresponding to statements 4 and 5) presented a positive index of acceptance with 96% of total agreement. This perception was also evidenced by users in the free evaluation question, with comments such as: "light and easy to understand, that is, very intuitive" (Participant ID02) and "can easily be used in a practical way on a daily basis" (Participant ID09).

The evaluation of the user context (corresponding to statements 6, 7, 8, and 9) presented the result of 86.5% of total agreement. When evaluating separately the statements, it can be observed that for half of the users learning through location was indifferent to motivate them in their frequency of use.

The use of images and examples was positively accepted by most users, who also commented that "images help a lot in memorization" (Participant ID02). Some users missed being able to choose at some point the type of place they wanted to learn. Another issue that was raised is the use of sound for pronunciation. This point goes along with the work of Sundberg and Cardoso [66], who propose the use of music for vocabulary acquisition.

Regarding motivation, one user suggested using gamification and social media interaction to encourage greater use of the application. These suggestions are in line with the findings in the work of Hao et al. [20] and Liu et al. [67] and can be implemented in future work. Also, it was observed that the use of artificial intelligence in the second language (L2) vocabulary acquisition can be incorporated in ULearnEnglish as presented in the study of Ginn et al. [36].

7. Conclusions

This study presented a positive response to the use of context-aware ubiquitous learning (CAUL) technology to aid in learning a second language. Applying ubiquity allied with incidental vocabulary acquisition strategy for English vocabulary learning can engage the learner since the user's context and preferences are considered. Also, using new words from the learners' day-to-day routine can help these learners recall, retain, and practice more the words learned, contributing to the improvement of the others' second language skills (reading, speaking, and listening skills).

Based on the recommendations of the DSR method, ULearnEnglish was designed with the support of specialists in the English vocabulary learning area and observing the main challenges the students face when learning a new language. Besides, to evaluate its practical contribution, learners used it in real life for 21 days. The TAM evaluation showed a favorable response to localization use to assist the participants in their English

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vocabulary learning. ULearnEnglish obtained acceptance of 78.66% for the perception of usefulness, 96% for the perception of ease of use, 86% for user context assessment, and 88% for ubiquity. Beyond the language teaching area, this study demonstrates an opportunity for future research concerning the different areas of education that intend to use context-aware ubiquity learning (CAUL) technology to assist the learner.

Although the present study showed positive results, there are also limitations and room for the ULearnEnglish's improvements. The application's releasing for only one mobile platform (Android) restricted the number of users for testing. In a future study, the ULearnEnglish application should be made available for other platforms. Besides, future works could use video and audio content based on the learner context. Also, an integrated note-taking feature could be implemented to help learners deepening their vocabulary comprehension. Additionally, integrated artificial intelligence techniques, such as object recognition and speech recognition could help the learners reinforce and assess their vocabulary learning. ULearnEnglish source codes is available at a public repository and can be downloaded and evolved to contribute to these future works.

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Abbreviations

The following abbreviations are used in this manuscript:

API	Application Programming Interface
CAUL	Context-aware ubiquitous language learning
DSR	design science research
JSON	JavaScript Object Notation
MVC	Model - View - Controller
PEOU	perceived ease of use
PU	perceived usefulness
PUV	perceivedubiquity value
TAM	Technology Acceptance Model

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