# Agile Development of a Custom-Made Vocabulary Mobile Application: A Critical Qualitative Approach

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## Abstract

**There have been some observed studies and developed applications (apps), with a concentration on Mobile Assisted Language Learning (MALL), and no consideration of communicative needs of the learners; besides, these studies focused on either the theoretical aspects or the utilization of the available apps in the market (Burston & Athanasiou, 2020). Hence, Vocabulary Guru (VG), a custom-made mobile application, was developed based on a critical framework and an agile approach to fill out the gap. To tackle the issue, after carrying out a qualitative needs analysis via interviews, the first version of the app was developed and released to the target intermediate EFL university students. The next iterations were developed interactively and creatively, in congruence with the feedback received from the target learners. This cycle of incrementing and recoding of the app continued until the attractor basins superseded. In the current paper, to shed light on how dynamically the interaction between learners and developers can yield in applications, which are more user-friendly and appropriate for a unique pedagogical setting, the life cycle of VG has been discussed. The agile app development processes of the current study may be useful for vocabulary specialists, teachers, educators, app developers,**

**and pedagogical foundations involved in or considering the design and development of mobile apps by critically analyzing the unique needs of the target population in an interactive dynamic, agile life cycle. The developed app (i.e., VG) may also be utilized by EFL learners who would like to learn academic vocabulary in an educational context.**

With the widespread emergence of web technology in the late twentieth century and the succeeding advent and growth of mobile technology, devices, and especially smartphones in the early twenty-first century, using mobiles in human's daily life is not a matter of choice anymore. Smartphones have become an inevitable companion for many people. They have penetrated and integrated into human life so profoundly that the presence of mobile technology per se seems blurred. The term *everyware,* introduced by Greenfield (2010), refers to ubiquitousness and pervasive nature of mobile technology as facets of the same paradigm of interaction. Everyware uses wearable computers and artificial intelligence (AI) to access all places, which may seem unreachable without its existence and penetration; meanwhile, the presence of everyware is so natural and relaxing that the intricate technology itself has disappeared from the ubiquitous functionality.

On the other hand, the English language has become so widespread in various aspects of human life such as world economy, mass media, entertainment as well as academic endeavors that it is considered as a lingua franca (Bowles & Cogo, 2016). Meanwhile, using technology, including everyware, may facilitate and enhance learning the English language as a universal means of communication (Kukulska-Hulme & Shield, 2007). Everyware includes mobile devices and smartphones widely used for learning objectives. Klímová (2018) carried out a literature search in the databases of Web of Science, Scopus, and ScienceDirect. Accordingly, it has been found out that using mobile devices, smartphones, and the relevant apps has

provided a promising and positive impact on learning English as a foreign language, especially on the motivation and the level of learning vocabulary.

There have been some researches carried out in Iran, with a concentration on MALL. The focus of the observed studies (T.-W. Chan et al., 2006; Foomani & Hedayati, 2016; Jafari & Chalak, 2016; Malekzadeh & Najmi, 2015; Rahimi & Miri, 2014; Samaie, Mansouri Nejad, & Qaracholloo, 2018) has been either on the theoretical aspects of MALL or the utilization of available apps in the market. As Heil, Wu, Lee, and Schmidt (2016) observed in their study, "despite a pedagogical shift toward more communicative approaches to language learning, these apps are behaviorist in nature" (p. 1). Accordingly, it is evident that the developed apps, regardless of what they claim, are not based on the communicative needs of the learners and are still sticking to the principles of behaviorism.

Taghizadeh (2019) emphasized that: "Needs analysis is considered a necessary first step in designing a course" (p. 1), to highlight the importance of considering the participants' attributes and demands. Huang (2019) also mentioned that needs analysis is the fact-finding phase and an intrinsic building block of curriculum development. Regardless of what was mentioned before, none of the observed mobile apps were developed or customized based on the needs and expectations of Iranian English as a Foreign Language (EFL) learners. Furthermore, socio-cultural factors were not dealt with, in any of the observed Iranian studies. Telecollaboration is a significant socio-cultural aspect of education (Hwang, Tsai, & Yang, 2008; H. Y. Wang, Liu, & Hwang, 2017), which may enhance learning. It may bring many advantages to the pedagogical settings; nevertheless, it has not yet been widespread (Dooly & O'dowd, 2018; Helm, 2015; Sadler & Dooly, 2016).

Based on what earlier stated, in today's concept of the universal village, many people would like to learn the English language; moreover, new mobile smartphones are so widespread and already exist in human life. Also, the positive impact of using mobile technology for teaching/learning various

aspects of language has been observed frequently in the literature (Liliia & Gulnara, 2016; Lin & Lin, 2019; P.-L. Liu & Chen, 2015; Nushi & Eqbali, 2017; Tai & Ting, 2020; B.-T. Wang, 2017). Hence, using mobile phones to teach different areas of language (e.g., vocabulary) seems plausible and practical. However, there is no consideration regarding the unique individual attributes of Iranian EFL learners in the present observed mobile apps; neither is any mobile app developed by envisaging socio-cultural aspects and personal preferences of the learners. Therefore, the purpose of the current study was to develop a custom-made mobile app for learning English vocabulary while considering socio-cultural aspects and particular needs of Iranian EFL learners to fill in the gaps in this realm.

In the next section, the related literature is critically reviewed to shed light on different perspectives of developing vocabulary mobile apps via agile methodology.

## Literature Review
### The Emergence of Technology in Education

The emergence of technology and especially the web in the late twentieth and the early twenty-first centuries have brought about numerous changes in various aspects and realms of human life globally (Kumar & Paiva, 2020; H. Y. Wang et al., 2017). As Greenfield (2010) observed, technology presence in daily human life is so pervasive and widespread that people do not notice its existence, and hence, it is blurred. This penetration into human life is greatly influenced by mobile technology in general, and mobile apps in particular.

### Mobile Apps in Teaching English as Foreign Language (TEFL)

With an outburst of growing mobile technologies and especially mobile phones in the early twenty-first century, the concept of everyware encountered a broader scene for actualization. The positive impacts of technology and especially mobile devices, smartphones, and the related apps are highlighted

in the literature by Basal, Yilmaz, Tanriverdi, and Sari (2016), Klímová (2018), and Zhang (2018). Portability, individuality, availability, adaptability, and usefulness are among the several features, which mobile technology can bring to human life (Criollo-C, Luján-Mora, & Jaramillo-Alcázar, 2018; Mehdipour & Zerehkafi, 2013; Rossing, Miller, Cecil, & Stamper, 2012). The English language has long been used as a lingua franca (Bowles & Cogo, 2016; Jenkins & Leung, 2017); it has been proved to be useful for providing people with many opportunities to progress without being dominated by the culture of the advanced countries (De Sousa Santos, 2004; Muhr, 2020). With the advent and widespread availability of mobile networks and mobile phones, there has been a growing interest in developing apps for learning/teaching the English language all around the world. Klímová (2018) mentioned that "… thanks to their ubiquitous nature, mobile phones and smartphones are nowadays widely exploited in education, including foreign language learning" (p. 2).

## Challenges of MALL in English as a Second Language (ESL) Environment

There are many areas of interest and research in this field, such as vocabulary learning, short message services (SMS), multimedia messaging service (MMS), and mobile applications (apps), to name a few (Lin & Lin, 2019; Taj, Sulan, Sipra, & Ahmad, 2016). Regardless of many advantages and positive aspects of using apps to learn a language and especially vocabulary, there are some challenges in this realm. According to Heil et al. (2016), the developed apps lack the fundamental aspects they claim they pursue; they are almost decontextualized and not developed to suit the target population's unique or eccentric characteristics. Burston (2015) mentioned that a lack of objective and quantifiable outcomes is also one of the other challenges of MALL research. He conducted a meta-analysis of 291 MALL studies over two decades, which showed that only 35 projects were carried out for one

month with only 10 participants; the rest of the cases even did not show this minimal duration and number of subjects. Also, the inadequate design has caused a failure in addressing numerous variables that may be due to an excessive "technocentric" approach, which radically focuses on the technology itself rather than the customizable aspects of learners (Kumaravadivelu, 2003, 2006).

Burston and Athanasiou (2020) provided a comprehensive overview of MALL studies from 1994 to 2018. The investigation was based on "the analysis of over 2000 MALL studies that have appeared in almost 500 distinct journals and presentations in conferences given by nearly 300 different professional organizations" (p. 1). Accordingly, once again, it was revealed that there were serious design flaws, especially regarding the objective assessment of the outcomes, the small number of participants, short treatment sessions, and not even defining one or the other. They continued that "the use of MALL to support interpersonal communication has been virtually non-existent" (p. 1).

## Relevant Studies Conducted in the EFL Environment
Based on the literature review of this study, the studies carried out in Iran either focused on the theoretical aspects of MALL or utilized the available apps in the market. One of the popular messaging systems, which is used in Iran and has not yet been filtered, is WhatsApp. Jafari and Chalak (2016) worked on "the Role of WhatsApp in Teaching Vocabulary to Iranian EFL Learners at Junior High School." They applied a mixed-methods design with a group of 30 male and 30 female students studying at two male and female junior high schools in Isfahan. The findings indicated that using a mobile app has a significant impact on learning English vocabulary; also, they found no significant difference between male and female EFL learners in this regard.

T.-W. Chan et al. (2006) defined seamless learning as a learning model in which students can learn whenever they are curious to learn in different

learning scenarios, using a device as a mediator. Foomani and Hedayati (2016) employed a seamless learning design in teaching idioms in an Iranian context. They did not use any particular app to teach the idioms; learners were required to take photos and prepare artifacts to share ideas regarding the idioms they had studied in class. The efficiency of WhatsApp for self and peer-assessments of oral language proficiency has been investigated by Samaie et al. (2018). In this study, the researchers used WhatsApp as a tool for assessment. Malekzadeh and Najmi (2015) studied the impact of "Mobile-Assisted Language Learning on Guided Writing Skill of Iranian Upper-Intermediate EFL Learners." The participants in their study did not use any particular mobile app; they were supposed to send messages via a mobile-native messaging system (SMS) to practice, share, and learn grammar. Rahimi and Miri (2014) investigated "The Effect of Mobile Dictionary Use on Language Learning." In this study, a mobile dictionary was utilized.

Therefore, in no study, a custom-made app was developed to teach the English language to Iranian EFL learners. In all of the observed studies, either an available mobile app was utilized, or a theoretical concept of MALL was approached (Burston, 2015; Burston & Athanasiou, 2020). As Heil et al. (2016) observed in their research, "despite a pedagogical shift toward more communicative approaches to language learning, these apps are behaviorist in nature" (p.1). Furthermore, the highly structured inflexible traditional methodologies like Waterfall, are not customer-centric (Khalifa & Verner, 2000). Whereas, considering individuals' needs, their relationship and interaction over tools, especially their collaboration during the development process, are pivotal, in agile methodology; therefore, rather than following predetermined plans and documentation, and numerical assessment, the focus of agile methodology is on immediate response to the participants' needs, and on producing the working software as soon as possible (Molina-Ríos & Pedreira-Souto, 2020). According to F. K. Chan and Thong (2009), traditional methodologies of software development are based on two assumptions: first,

they assume that customers do not know their requirements, but developers know, and second, customers cannot foresee their needs, so developers should provide them with extra features for their probable needs in future. They continued that contrary to the traditional methodologies, agile methodology assumes that neither customers nor developers know completely what the system requirements are, therefore, they cooperate to find out the most suitable aspects and features to be implemented in the software or application.

Hence, the purpose of the current study was to develop a custom-made mobile app that considers all of the shortcomings of the observed studies to fill out the present gap in this realm. Accordingly, based on the principles of the task model and the agile methodology, a semi-structured oral interview was carried out to find out their expectations and demands regarding learning vocabulary via a mobile app (See appendix D). Then, the researcher, in a series of interactions with the participants, developed multiple versions of the app to meet the requirements of the situation. It is crucial to mention that according to the principles of agile methodology, especially "On-site Customer" and "Adaptive Planning" principles (Asfour, Zain, Salleh, & Grundy, 2019), the only criterion for developing a new version was a new demand posed by the participants, and the only criterion for the fulfillment of the demand was the feedback received from the participants. Therefore, the ultimate purpose of the current investigation was to develop a custom-made mobile app to meet all the demands of the participants of this study.

## Limitations and Delimitations of the Study

The following limitations and delimitations were considered in the current investigation. The researcher could not choose the participants of the study randomly to increase the generalizability of the findings of the research. Due to the scarcity of male learners in the chosen classes, only female learners were considered in the study. Besides, merely EFL learners whose native tongue was Persian were studied since learners with different mother tongues

were not available; learners with different mother tongues may yield different results. The level of technology savviness may affect learners' performance, but it was not captured due to limitations of the available equipment.

The following aspects were considered to take into account the external validity and transferability of the findings. The participants were altogether 30 sophomore Persian-speaking Iranian EFL learners between 18 to 35 years old. Learners with different levels of proficiency may act differently while learning vocabulary either via traditional methods or via a teacher-developed custom-made mobile app. The researcher selected an intermediate level of proficiency since the majority of the target population of this study, who were potential consumers of the custom-made mobile app (i.e., VG), were intermediate Iranian EFL learners majoring in English literature and translation. Furthermore, communication in English is more practical at this level, compared with the lower levels of proficiency (NB: advanced students were low in number at available intact Bachelor of Art classes).

Furthermore, considering the result of needs analysis, the researcher selected only academic vocabulary based on the frequency and domain of the words from "The Academic Vocabulary Lists" (Gardner & Davies, 2013; He & Godfroid, 2019). Due to time limitation (12 academic weeks/sessions), and the necessity of rehearsal for internalizing the target vocabulary, each session, seven new words were worked on, which made 84 words. This study was conducted on EFL B.A. learners majoring in the English language; students from the other disciplines and levels of proficiency may show different perspectives and performance regarding learning vocabulary via a developed custom-made mobile app.

The next section deals with the theoretical framework of the study and the interaction between different dimensions of the task model. These theoretical aspects shed light on how interaction among all the facets of the model affects the agile development process.

## Theoretical Framework of the Current Study

The task model (Taylor, Sharples, O'Malley, Vavoula, & Waycott, 2006) for mobile learning, reflects all principles of post-method and critical cyclic agile app development methodology (Asfour et al., 2019; Chande & Flora, 2013; Dingsøyr, Nerur, Balijepally, & Moe, 2012; Flora, Chande, & Wang, 2014; Petersen & Wohlin, 2009; Sharma, Sarkar, & Gupta, 2012). Therefore, to systematically and dynamically position and develop the mobile app of the current research, the task model and its components are defined first, and then the interaction between the task model and the agile methodology is discussed.

## The Task Model

Sharples, Taylor, and Vavoula (2007), and Taylor et al. (2006) stated that the task model centers around providing a coherent perspective of the activities, the people, their contexts, the tools and technologies used by them, the tasks and their cognitive processes as well as knowledge management and social interactions. The socio-cultural aspects of this model are rooted in the work of Vygotsky (1980), who emphasized the developmental and dynamic nature of learning in an interactive mutual environment. Meanwhile, the task model primarily deals with and concentrates on mobile learning. It is also rooted in the activity theory (Uden, 2007) while expanding and including complex interdependencies and the dialectic of learning and technology (Frohberg, Göth, & Schwabe, 2009).

The structure and interactive components of the task model are depicted in Figure 1 to shed light on how they interact with each other in the task model for mobile learning.
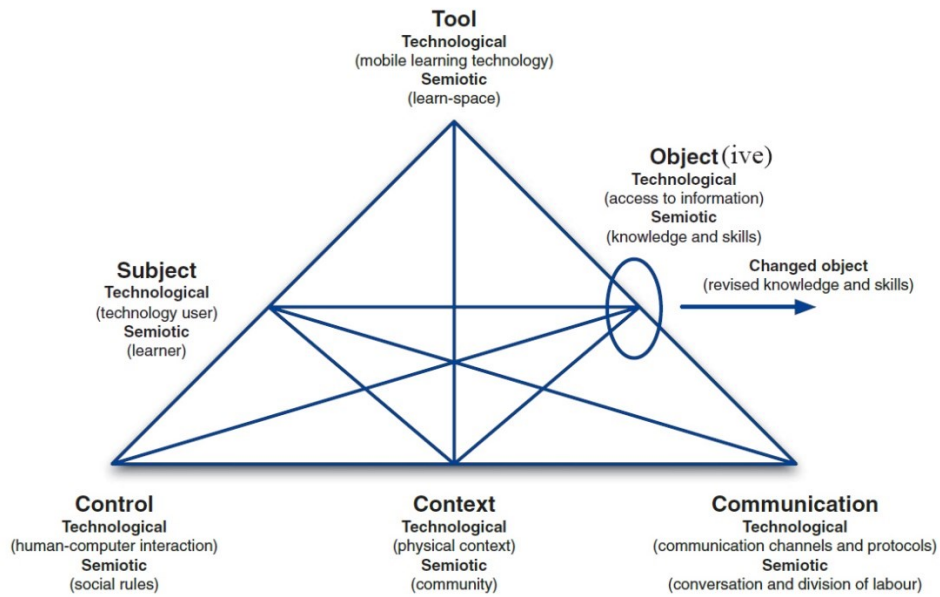
*Figure 1.* The task model for mobile learning. Reprinted from Taylor et al., (2006)

## Components of the Task Model

According to figure 1, the task model has three components which are the subjects/learners, their objectives, and the learn-space/tools. The term 'tools' refers to any phenomena, which are used to fulfill the requirements of achieving the learners' goals such as books, videos, or Learning Management System (LMS) facilities as well as teachers and experts. The term 'subjects' refers to technology users/learners who are involved in the study. Finally, the term 'object(ive)' refers to the dynamic target knowledge and skills the subjects want to achieve.

The crucial elements for mobile learning, according to classical views of learning, which are often neglected or not dealt with overtly and comprehensively are control (social rules), context (community),    and

communication (conversation & division of labor) (Frohberg et al., 2009; Sharples et al., 2007; Taylor et al., 2006). In the following sections, the integration of agile methodology and the components of the task model are discussed.

### Agile Methodology and the Task Model

Z. Liu, Gao, and Long (2010) stated that mobile app development is a complex process with more vulnerability, which may lead to more errors compared with web and desktop applications. Chande and Flora (2013), based on their review and analysis of the literature, stated that the process of mobile app development is different from those of traditional and rigid methods of software development. According to Asfour et al. (2019), "agile development methods have been proposed as a natural fit for mobile app development contexts" (p. 29), which can foster and enhance these aspects. Corral, Sillitti, and Succi (2013); Dingsøyr et al. (2012); Petersen and Wohlin (2009); Sharma et al. (2012) stated that agile methodology could meet the dynamic requirements of the software development companies.

Therefore, as its framework, the present study aimed at applying the fundamental aspects of agile app development methodology to the task model introduced by Sharples et al. (2007) and Taylor et al. (2006).

## Method

### Participants

Due to the limitations of selecting classes for the study in a pedagogical situation, a convenient sampling method was employed for choosing the subjects of the current study. Accordingly, from 141 students in 6 intact classes (the available researcher's classes in the university), 30 female students were chosen randomly. Therefore, the participants were 30 female Persian-speaking Iranian EFL learners whose ages ranged from 18 to 35 years,

and all had formally studied English for two years, and all were majoring in English language and literature at university.

## Materials
### *Target Vocabulary*

The following section discusses the criteria that center around the domain and the frequencies of the words for selecting the target vocabulary.

**Domain and Frequency of the Selected Vocabulary.** Hiebert, Scott, Castaneda, and Spichtig (2019) defined the difficulty level of vocabulary as the indices of the frequency of appearance in written language, age of acquisition, and utility in different content areas. Balota, Yap, and Cortese (2006) emphasized that the frequency of words influences all word recognition tasks virtually. He and Godfroid (2019) also defined the frequency of words as a criterion for word selection. There are billions of English vocabulary available that make it hard to find the frequencies of their occurrences. Tono (2019) observed that although the convenient size of corpora, which is the source of finding the frequencies of the words, can be up to thirty billion words, the frequencies can be easily analyzed via a user-friendly corpus query program on a small laptop computer. There have been numerous corpus query systems in the literature. Christ (1994) mentioned two types of query systems: the ones that are based on online query interfaces such as WordNet and those that are rooted in morphological knowledge bases such as the CELEX database. Gärtner and Jung (2020) provided a broad overview of the history of corpora and corpus query tools. In their state-of-the-art investigation, three generations of query systems were explained in detail. According to their in-depth study, the 1990s (first generation) was significantly involved in text corpora, such as COSMAS11, Linguistic Database program (LDB), Corpus Workbench (CWB), EMU, and MATE. They continued that later in the beginning of the 21$^{st}$ century, the second

generation of corpus query systems emerged with a focus on dependency syntax annotations, such as TIGERSearch, The ICE Corpus Utility Program (ICECUP), VIQTORYA, ParaConc, and CorpusSearch. Based on their study, during the last decade, the development of new corpus query systems slowed down. However, scalability, adaptability, the inclusion of more potential users, and the unification and standardization of query languages have been the focus of the era. The most popular corpus query systems of the time have been GrETEL, Fangorn, ICARUS, CLARIN Federated Content Search (CLARIN-FCS), CQLF, KoralQuery, KorAP, SETS, Multilingwis, and graphANNIS (Gärtner & Jung, 2020).

In the current study, based on the findings of the needs analysis and the learners' major (i.e., English language and literature), the selected domain was academic vocabulary. In this regard, the target words were selected based on their frequencies in 120 million words of academic texts in the **Corpus of Contemporary American English** (COCA) (Davies, 2017), and the information obtained from the query interface on Academic Core Vocabulary website (Davies & Gardner, 2019).

To choose the number of words to be taught in each session, the researcher considered the capacity and limitations of human memory, discussed in the next section.

### *Memory and Vocabulary Selection*

Memory has a central role in learning processes; it has a crucial role in rehearsing and remembering words; therefore, its capacity and functionality should be considered while preparing learning materials. In this regard, Miller (1956) remarked that number 7 (plus or minus 2) is a magical number. He asserted that this boundary is due to our short-term memory limitations for processing new information; this means that humans can hold 7 +/- 2 new items in his short-term memory in a fraction of time, a concept confirmed by Ozdemir (2017). Phillips, Shiffrin, and Atkinson (1967) defined their model

of memory as a buffer consisting of the temporary state of memory and a long-term storage state. They remarked that the buffer, which is similar to short-term memory, has a limited and constant capacity that depends on the nature and the number of items that can be held in memory simultaneously, i.e., the more complex the items are, the less the estimated buffer size will be. Baddeley, Hitch, and Allen (2019) accentuated the inter-relationship between short-term memory, working memory, and long-term memory; Covre, Baddeley, Hitch, and Bueno (2019) remarked the limited capacity of executive resources in working memory.

In the current study, based on what was mentioned and considering the time limitations, seven words were taught in each session, based on the criteria of word selection already discussed in the current paper. Hence, totally 84 academic vocabulary items were selected to be worked on via VG. The participants were supposed to learn seven words each week (totally 12 academic weeks) at their own pace.

In the next section, the tools that were utilized in the life cycle of VG development are discussed in detail.

**Tools**

According to Sharples et al. (2007) and Taylor et al. (2006) any sort of material, content, instrument, device, and the other facilities, such as electronic media and devices as well as books, maps, paintings and the like that are used in the process of learning/teaching, are all different varieties of tools. In this way, they even consider language, society, and culture as tools that are consumed during the learning process.

The researcher focused on how tools were prepared and how their content was delivered to follow a harmonious axiom. As Frohberg et al. (2009) defined, regarding the manipulation and development of content by the tools, there are five levels in the task model; content delivery, interaction (with tools), guided reflection, reflective data collection, and content construction.

According to agile methodology, the feedback of the participants was the base of defining the expected and hence necessary functions of tools to be considered for tool selection. So, except for content construction, the learners' preferences, based on the interviews and mutual discussions, focused on content delivery, interaction (with tools), guided reflection, and reflective data collection. These aspects and functions were the foundations for selecting tools for VG.

### Tools Selected Based on Needs Analysis

The tools (including the digital content) which were selected and integrated into VG based on the learners' demands and their feedback, during the app development life cycle, are as follows: frequent academic vocabulary (including their phonetic symbols and audio files for learning pronunciation), a note-taking section, online help, chat rooms, forums, and email correspondence.

Also, since the participants demanded to be notified when an emergency case was on the way (e.g., an online daily quiz), or a new event such as a meeting was arranged, the following immediate online and offline notification services were provided: email-based and cloud-based messaging notification alerts, observed once when learners were online. Also, in-app messaging campaigns added interactivity to the learning process. The message pop-up windows remained active until the learners clicked on them and did what they were required to do. In this way, the learners were informed of the upcoming events on time.

### Technologies as Tools

According to the task model, technologies are considered as tools used in the life cycle of app development (Frohberg et al., 2009; Sharples et al., 2007; Taylor et al., 2006). The leading technologies which were used to develop VG based on the agile approach will be discussed in the following sections.

*VG Mobile Operating System*

According to Sheng et al. (2019), an operating system is an execution environment to run the other software. In the current study, the statistics obtained from independent websites were gathered to find out which OS has the most significant share in the mobile market worldwide and the Iranian market exclusively. The two most popular independent data-gathering companies on the web, Net Market Share (NetMarketShare, 2019) and StatCounter Global Stats (StatCounter, 2019), were chosen to account for the required statistics regarding the most used operating systems. Based on the statistics obtained from Net MarketShare analysis, up to December 2019, 69.98% belongs to the share of Android and 28.86 belongs to IOS; the rest belongs to the other operating systems worldwide (See appendix A). Statistics obtained from the StatCounter website revealed that about 90% of Iranians' mobile devices run Android, and the rest run the other operating systems, including IOS (Appendix B). Financial Tribune, the first Iranian English Economic Daily, reported: "According to Iran's Telecom Ministry statistics, Apple iPhones have an 11% share of the smartphone market. It is estimated that 6 million Iranians have an iPhone" (Finantial Tribune, 2020, para. 11); It was highlighted that Samsung and Huawei Dominate 83% of Android Phone Market of Iran.

The statistics mentioned earlier reveal that there are two main widely used mobile operating systems worldwide, Android and IOS. Kaya, Ozturk, and Gumussoy (2019) observed that IOS is a closed operating system that is used on mobile devices produced by Apple, Inc., and Android is an open-source operating system developed by Google, used on different mobile phones.

Due to the limitations of time and budget, the two main mobile operating systems, i.e., Android and IOS, could not be developed side by side. Furthermore, since, according to the statistics mentioned above, the majority

of mobile devices around the world and in Iran, run Android OS, in the current study, Android OS was selected as the platform to develop VG application.

### Bluestacks for Windows and IOS

Bluestacks App Player (BlueStack Systems, 2020) is a software that can run Android apps and games on different versions of Windows, MAC OS, and IOS. Since a few of the learners had no mobile device with minimum requirements to run VG or had an Apple device that runs IOS, Bluestacks was introduced so that they could run VG on their windows, MAC OS, or IOS devices.

### Android Studio

The official Integrated Development Environment (IDE) to develop Android-based applications is Android Studio by Google, Inc (Google LLC, 2019). In the current study, Android Studio was the primary IDE which was used to develop VG.

### Android Studio Programming Language

There are three programming languages in Android Studio IDE: Java, Kotlin, C++. In this study, due to the researcher's expertise, Java was chosen as the programming language to develop VG. To develop the application of this study (i.e., VG), the free license platforms and software, which are discussed in the next sections, were used.

### Moodle

Moodle is an acronym for Modular Object-Oriented Dynamic Learning Environment, which is a free and open-source LMS, written in PHP and distributed under the GNU General Public License (Moodle Inc., 2019). In the current study, the Moodle platform was used to generate chat rooms, forums, and quizzes.

### Messaging Tools

To increase user engagement and retention, in case they may forget to study or join an upcoming event, the following tools were used: email-based

reminders, Firebase Cloud Messaging (Google, 2019a), and Firebase In-App Messaging (Google, 2019b).

### *App Functionality Test Tools*

The most crucial pre-release phase of the life cycle of software is the testing phase. In the current study, VG was tested on multiple physical and virtual mobile devices via Android Studio and Firebase Test Lab (Google, 2019c). VG passed all the tests mentioned above, with no failed, flaky, skipped, or inconclusive results.

### *Quizzes*

After each session, learners were provided with an online drag and drop quiz based on seven words they had studied. During the quizzes, the learners were supposed to recognize and recall the vocabulary by filling in the blanks with the appropriate words. The quizzes could be done as many times as the learners needed them. The researcher kept all the records in a database for further review and analysis.

### *Interviews*

Yin (2018) attested to the appropriateness of interviews to collect information regarding the needs and necessities of a pedagogical situation. Therefore, in the current study, semi-structured interviews were used as a means to carry out a needs analysis.

### Procedure: Life Cycle of VG Development

Defining the exact phases of the software development life cycle is of utmost importance for developing and implementing an efficient app for the target population. Inukollu, Keshamoni, Kang, and Inukollu (2014) mentioned the following reasons for low-quality apps: developing apps without knowing the requirements and with no design, having not enough technical expertise in the field of software development, not enough testing and implementation before release, and finally, not appropriate and enough post-release maintenance.

Therefore, to consider and actualize all these crucial aspects, VG went through 3 phases during its life cycle: the first phase was defining the algorithm and flowchart based on the theoretical framework of the study, the second phase was carrying out the qualitative needs analysis, and the last phase was developing VG programmatically and practically. The following sections elaborate on these phases in detail.

### Phase 1: Defining the Algorithm and Flowchart

Language is such a dynamic and complex phenomenon that makes it impossible to approach it as a linear system (Larsen Freeman, 2012). Also, according to agile methodology, in the life cycle of app development, there are many nonlinear iterations based on the feedback received from the users (Asfour et al., 2019; Chande & Flora, 2013; Corral et al., 2013; Dingsøyr et al., 2012; Flora et al., 2014; Sharma et al., 2012). Hence, before planning and designing the first and also each new iteration, there is a temporary release stage, which is an attractor basin. Then based on the critical analysis and review of the findings, the system goes through another dynamic phase/repeller state until it settles down in a new attractor basin/state (De Bot, Lowie, & Verspoor, 2007) by releasing the next version. Therefore, there were multiple minor or major revisions carried out and released during the development process of VG. Some of the minor revisions were done multiple times even daily, for instance, modifications such as changing the size and color of the fonts to make them more legible to the participants based on their daily feedback. Figure 2 depicts the complex and dynamic mutual inter-relationship among various elements involved in the life cycle of VG taken as the algorithm and flowchart of the study:
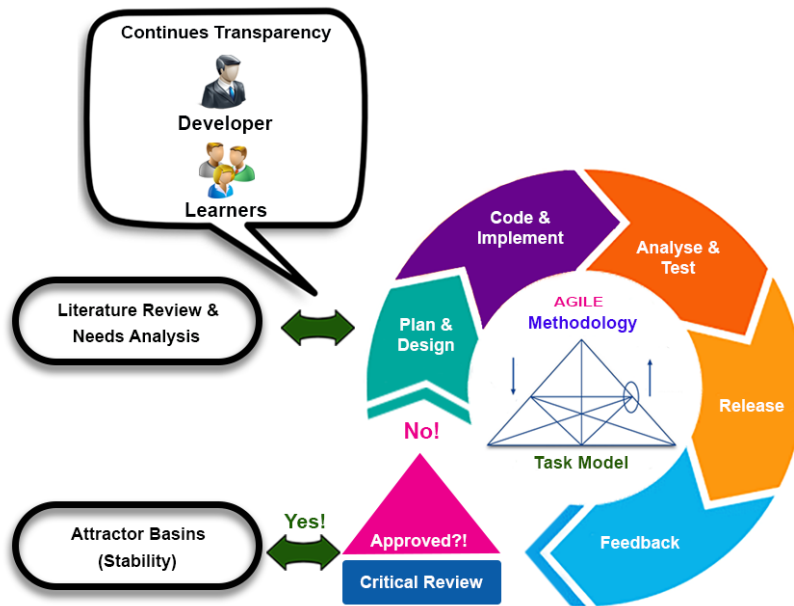
*Figure 2*. The Algorithm and Flowchart of VG Development.

## Phase 2: The Qualitative Needs Analysis

As the second stage of the life cycle of VG, face-to-face interviews were carried out as a tool to collect information regarding the needs and necessities of the target population (i.e., university students who were majoring in English language translation and literature). Therefore, first, to establish rapport with the candidates, some questions regarding their demographic and personal information were asked. Then, the interviewer asked the predetermined and flexible questions to collect the required information necessary to develop VG based on the candidates' experiences, expectations, and opinions. Since the interview was semi-structured, the candidates were encouraged to talk about their stances and opinions about using mobile apps for learning vocabulary.

The participants were required to write down their answers in Persian after the interview for further analysis by the researcher. Since the participants were intermediate EFL learners who share the Persian language as their

mother tongue and may not be proficient enough to talk and write about their opinions in English easily and the fact that their opinions regarding the qualitative questions are necessary for software development at this stage, all the questions were asked in Persian. The participants were also required to answer in Persian.

The findings of the needs analysis were analyzed qualitatively to establish a foundation for choosing and defining the required features to be considered in the process of VG development. The emerged themes are discussed in the data analysis section.

### *Phase 3: VG Development*

At this stage, the researcher defined and prepared the content of the study to be taught via VG. Content included vocabulary and their meanings, besides sample statements that were taken from Cambridge online dictionary (Cambridge, 2020), context used to teach them, and the quizzes to self-assess learners' progress. Although the researcher selected the content, the selection criteria were based on the findings of needs analysis, and the feedback received from the learners directly, or via their performance in the related quizzes indirectly. After preparing the content of materials, the researcher planned and designed how to present them to the learners. At this stage, the design of the lessons and the related quizzes were defined. Each lesson consists of 7 words, their phonetic representations, their meanings in English, and their translations in Persian. The sample statements to contextualize the vocabulary and the relevant audio files were all in American English. Each lesson was followed by a drag and drop fill-in-the-blank quiz with immediate feedback, which can be reattempted as many times as necessary. At the next stage, to develop the mobile app, the researcher utilized an appropriate Integrated Development Environment (IDE) and the relevant programming language. In this study, Android Studio was chosen as the environment to develop VG; Java language was selected as the programming language to

write the codes necessary to run VG. Then, the necessary codes were written, implemented, and analyzed before going through the test stages during which both physical and virtual devices tested the produced app. Before releasing the first iteration of VG, it was tested by the Firebase online lab to make sure that it would run well on a variety of real devices. Having released the first version of the app, the researcher analyzed the feedback of the learners critically. If everything had worked well, which was a sign of VG settling down in an attractor basin, no new iteration would have been implemented, unless otherwise, the new repeller state would push the agile cycle of the task model to reactivate and generate another new version of VG to meet the requirements and necessities of the situation. For instance, upon the request of the participants to use the words in context, first sample statements taken from Cambridge online dictionary (Cambridge, 2020) were added to the definition and translation of the words in VG; then, the participants were encouraged to make the mold on them and produce their statements. Finally, they practiced them via the chat module online, and via the forum discussions offline. Also, they were provided with feedback received from their classmates and the researcher, both online and offline. The records of their interaction and the received feedback were all saved in VG for their further ipsative assessment (Gipps, 2003). The researcher also consumed these records for critical analyses as the foundation for developing the next version of VG. This never-ending cycle continues as long as the learners utilize the app, and there is a new concept, objective, and technological advancement in the market. Appendix C illustrates the final interface of VG and a sample lesson, including its relevant quiz.

In the next section, the interaction between the task model and agile methodology, and the impact of participants' feedback, emerged during a needs analysis on the development process are discussed in detail to clarify how various components of the integrated system function together in the life cycle of VG.

**The Task Model and Agile Methodology**

As Figure 2 depicts, in the core of developing VG, there is a mutual dialectical interaction between different facets of the task model and agile methodology, which is continuously evolving based on the conditions and repellers which emerge. Agile methodology explicates a qualitative approach focusing on a phronetic iterative analysis that mutually moves from emic, or emergent shreds of evidence, to an etic use of existing models, explanations, and theories (Tracy, 2020). Regarding this qualitative and dynamic procedure, Tracy (2020) explained that:

> Rather than grounding the meaning solely in the emergent data and coding for a huge range of events, activities, participants or relationships, an iterative approach focuses on specific aspects of the data that extend theory or address practical problems and encourages reflection upon the active interests, current literature, granted priorities, and various theories the researcher brings to the data. (p. 209)

Therefore, when according to the findings of the needs analysis, the necessity of using a unique tool arose, unlike the traditional approaches of software development, the developer did not use the available tools in the market. Instead, based on the principles of agile methodology, besides consulting the authorities, the relevant theories, and the literature, the researcher utilized his tact and expertise (Kumaravadivelu, 2003), and the feedback of the participants to find out the most appropriate solution or workaround to deal with the repeller state. For instance, during the needs analysis phase, learners informed their interest in watching video clips that contain the target words. Nevertheless, the developer knew that he had neither any access to such video clips nor could he produce them. According to the task model, a video clip is a digital tool with its especial functionalities in different contexts. The researcher referred to the findings of the qualitative data analysis and found out that the underlying desire of learners to watch

video clips is rooted in their desire to learn how the words are used in an authentic context, and how the native speakers enunciate them. Next, the researcher delved into the literature, and also investigated the affordances available in the market to replace the required digital video clips with an appropriate tool that fulfills the same functionality (i.e., providing native pronunciation of the target vocabulary in an authentic context). Next, based on the flexibility the agile approach brought about into the life cycle of VG, and due to the low budget project and the licensing limitations, the following free licensing computer programs were selected to provide the participants of the study with the native-like pronunciation of the target vocabulary in authentic context (i.e., sentences selected from Cambridge online dictionary). Therefore, for generating the audio files of the pronunciation of the words and the sample sentences, Balabolka (Sergey & Ilya, 2020), which is a Text-To-Speech (TTS) free software, was used. Then, in order to modify the audio files of words and the sample sentences, Audacity (Audacity, 2019), which is a free, open-source, cross-platform audio software, was selected; following the dynamic principles of agile methodology, a necessity was mapped into the framework of the task model.

Accordingly, based on a constant comparative method (Charmaz, 2014), and via including prospective conjecture (Hallier & Forbes, 2004), novel theoretical approaches and methods were considered to pinpoint the best solution to the problem under consideration. Hence, in the heart of the life cycle of VG, there was a constant dialectical movement. This dynamicity was to meet the requirements that arose from the needs analysis. Subsequently, the outcome was gaged and tuned according to the feedback received from the participants of the study. The same procedure went on for all of the features and the required affordances of VG. The modifications were defined in the qualitative phase of the study. They were in congruence with the facets of the task model and the principles of agile methodology.

To shed more light on the procedures mentioned above, the communicative facet of the task model, its conceptual interpretation to the participants' shared viewpoint, and how it was integrated inside VG, are discussed next, based on the principles of agile methodology. Frohberg et al. (2009) defined six levels for communication facet of the task model: social setting, isolated learners, lose couples, tight couples, communication within a group, and cooperation. According to the findings of the qualitative phase of the study, the participants' stance regarding communication and its social settings centers around a tendency to cooperate and with the teacher/researcher as well. This tendency arose the necessity of providing them with a cooperative atmosphere (i.e., a new repeller emerged). Hence, to satisfy the need for settling down in attractor basins, which in turn was temporary, the researcher tried to map the need into the skeleton of the task model, to select the plausible affordances to add to VG, by delving into theory and practice, based on a phronetic iterative analysis. The researcher also utilized his expertise and methodology, as was discussed in post-method by Kumaravadivelu (2003, 2006).

In the current investigation, the records of the needs analysis depicted the concept of communication as mutual online cooperation and correspondence among the participants and the researcher. Therefore, an online chat module was selected to meet the required demands of the participants. Then, based on the task model, the software coding was carried out, and finally, the chat module was added to VG to provide the participants and the researcher with an opportunity to chat with each other online. After releasing the related version, via face to face interaction, the researcher found out that the participants were willing to have access to the chat history as well; so, chat history was added to the next minor iteration of VG. However, again, it could not meet the expectations of the participants; after working with the new release, the participants became interested in extending their discussions further to share their experiences and ideas regarding the target vocabulary

and the related topics such as how they memorized the words. Besides, they desired to be able to keep the records of their discussions and incrementally add to them. To meet the new requirement, the researcher tried to map this new repeller to the facets of the task model. Accordingly, a new tool was necessary to prepare the communicative facility to be integrated within VG. Therefore, in the next step, based on the principles of the agile approach, the researcher studied the literature, consulted various resources available via the internet, and finally decided to add a forum module to VG. This cycle of interaction continued until the need was satisfied; therefore, the system reached its tranquility state (i.e., attractor basins). Figure 3 shows this tool Integration Process graphically:
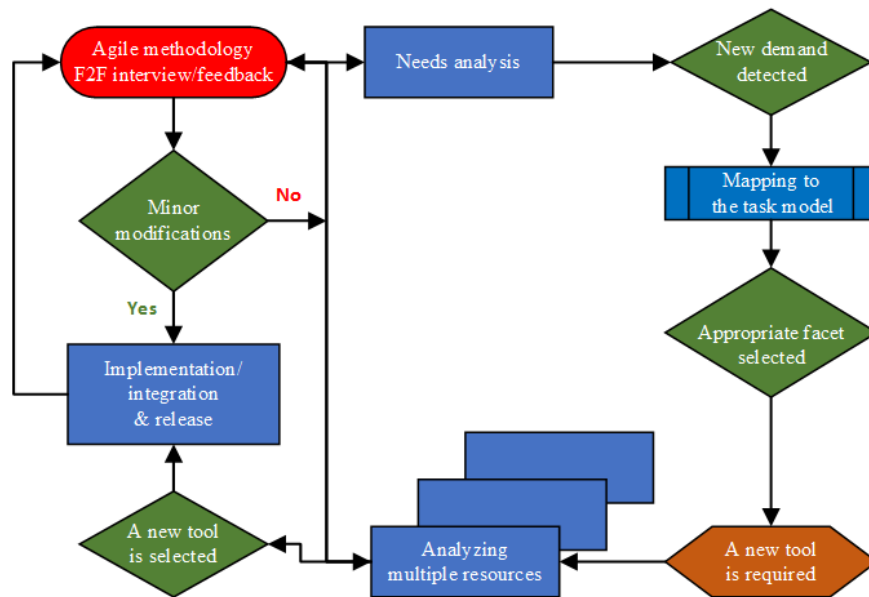


*Figure 3*. Interaction between Agile Methodology and the Task Model.

According to the principles of agile methodology, the software developers should not wait until the complete version of the application is

ready. Instead, the first version should be released as soon as it meets the minimum requirements of the target application based on the literature review, the objectives of the target customer/s (i.e., participants of the study), and the developer/s analysis and expertise (Asfour et al., 2019; Sharma et al., 2012). So, from the very beginning, facilities such as online chat or forums should not be added if they are not necessarily based on customers' views. Also, many aspects may emerge based on the demands of a unique situation, which may not be desirable for other settings. The mutual interactions, shown in figure 3, clarifies how this dynamic interwoven dialectical whole system functions. To shed more light on how this process functions, table 1 depicts the features that were added to or modified in successive iterations of VG, based on the principles of agile software development, rooted in the participants' views or commentaries (i.e., their feedback).

Table 1.

*Main Features of VG Added or Modified based on the Participants' Views or Commentaries*

| Life cycle | Participants' views/commentaries | Features: added/modified |
|---|---|---|
| **First release** | Frequent academic words, including their audio pronunciation and meaning in English, are necessary. | Words, the relevant audio files, and their meaning |
| **Pre-installation** | Some of the participants did not know how to install VG; hence, they asked for pre-installation help. | A web page with step by step instructions, including images |
| **Pre-installation** | Still, few participants could not install VG even by using the instructions of the web page. They asked for live help. | An online live chat module for the web page |
| **Second release** | The participants were willing to learn the phonetic symbols of the words as well. | Phonetic symbols from Cambridge online dictionary |

| Life cycle | Participants' views/commentaries | Features: added/modified |
|---|---|---|
| **Third release** | There was a great demand for observing words in their context. | Sample statements from Cambridge online dictionary |
| **Minor release** | A demand to change the font size to make the words more legible was pinpointed. | Font size increase |
| **Fourth release** | The participants inquired about keeping their records. | Moodle LMS |
| **Fifth release** | The participants repeatedly addressed facilities for self-assessment. | Automatized quizzes with immediate online feedback |
| **Sixth** | The participants desired to use each week's practiced vocabulary in a single coherent context. | Weekly cloze quizzes with words of the week |
| **Seventh** | There was a desire to listen to the audio files of the sample statements. | Audio files of the sample statements generated by Balabolka Text-to-speech free software |
| **Eight release** | Telecollaboration and the ability to interact with each other were highlighted. | An in-app online chat module |
| **Ninth release** | The participants were not able to arrange online meetings. They asked for an online board for meeting arrangements. Many of them had a desire to discuss vocabulary learning issues and sharing their experiences. | A forum module |
| **Tenth release** | There was an inquiry to be informed when a meeting/event is due, or a new version of the app is released. | Firebase in-app and cloud-based messaging |
| **Final release** | There was a necessity to take notes and save them for future study. | An in-app note-taking module |
| **Post final release** | Many participants announced a great demand for total ipsative assessment carried out at their own pace. | Two major online automatized quizzes with immediate online feedback |

It is necessary to highlight that evaluating the impact of all these facilities on improving the participants' experience of VG was derived from the ipsative assessment, which considers participants' personal feedback regarding their progress compared with their previous experience of VG (Gipps, 2003). Furthermore, the participants' practices via online chat sessions, discussions in forums, and online automatized quizzes with immediate feedback were all recorded automatically in the VG database and critically scrutinized for developing each new version of VG.

## Qualitative Data Analysis

The questions of the interview, which were used during the needs analysis phase, addressed the main facets of the task model, including context, tools, control, communication, subject, and object(ive) (See appendix D). Following the "On-site Customer" and "Adaptive Planning" principles of agile software development, discussed by Asfour et al. (2019), the researcher, left it open to the participants to extend the discussion and define the aspects and features, which may not be delved into by the by him. It is essential to highlight that during the cyclic agile process of developing VG, face to face dialectic interaction was not limited to the initial stage only, but they spread along all the process, so there was a recycling of the same questions in different time slots. For instance, the question which addressed students' willingness to cooperate and share their personal experiences via VG, led to the emergence of chat module in the first version of VG, whereas, the same discussion regarding the usefulness of the chat module introduced the necessity of adding a forum module to the next iteration of VG, for making chat appointments.

In the next phase, after collecting the data, the researcher used MAXQDA to qualitatively analyze the answers to the questions of the semi-structured interviews by using an iterative phronetic approach, as synthesized by Tracy (2020). First, in the primary-cycle coding phase, the data were coded. Due to

the dynamic nature of the study, a constant comparative method (Charmaz, 2014) was employed, writing in vivo codes (Strauss, 1987), i.e., terms used by the interviewees. Then, during the second cycle, the axial codes were determined based on the relevancy, frequency, and hierarchy of the primary codes, delving into the principles of the task model, agile methodology, and post-method pedagogy. In fact, via including a prospective conjecture (Hallier & Forbes, 2004), novel theoretical approaches and methods were considered. In the final stage, after reconsidering, recoding, and reinterpreting the codes and the relevant theories (triangulation process), as shown in figure 3, the analysis reached a theoretical saturation state "in which new data add little if any, new value to the emergent analysis coding" (Tracy, 2020, p. 235). The qualitative map of the processed data was generated by MAXQDA to show how the themes are connected (See Appendix E). Also, Table 2 was generated to depict and tabulate the themes developed based on the qualitative data analysis of the oral interview concerning different dimensions of the task model.

Table 2.

*Overview of the Emerged Themes Based on the Qualitative Data Analysis of the Semi-structured Interviews Concerning the Components of the Task Model*

| Factors | Context | Tools | Control | Communication | Subject | Object(ive) |
|---|---|---|---|---|---|---|
| **Issues** | Relevancy of environment and learning | Pedagogic roles of tools | Tightness of control | Social settings | Previous knowledge | Learning vocabulary |
| **Emerged themes based on the qualitative data analysis** | Independent & socializing context | Content delivery Interaction (with tools) Guided reflection Reflective data collection | Scaffolding (interaction between the teacher and the learners) | Cooperation Dialectic problem solving | Majoring in English language and literature for two years Intermediate | Recognition and recall of academic vocabulary |

The findings of the qualitative data analysis phase were used during the app development life cycle to account for the principles of agile software

development, discussed in section 4 of the current paper. Agile methodology is nonlinear; therefore, each phase is the foundation for the next one; this iterative, incremental procedure continues until the system reaches its attractor basins (Harshbarger, 2007; Larsen Freeman, 2012), then the tranquility continues until a new repeller (e.g., a new request or necessity) arises that pushes the cyclic procedure to be activated again.

Agile methodology acts upon the principles of multi-agent stigmergic systems. De Nicola, Di Stefano, and Inverso (2020) defined these systems as "collections of autonomous agents that operate according to some local rules and limited mutual awareness. They are a convenient formalism for representing several classes of complex systems and can support formal reasoning about them" (p.1). This cyclic agile development of VG, which is a nonlinear and multi-agent stigmergic system, is discussed in the next phase of the study.

**Agile Methodology in the Context of VG Life cycle**

As Asfour et al. (2019) and Corral et al. (2013) discussed, in the agile process of software development, contrary to traditional approaches, the developers do not wait till the software is completed. Instead, various iterations of the software are released so that the consumers will decide which factors should be enhanced, added, or even eliminated. Hence, there were even daily correspondence and negotiation between the developer and the participants.

Therefore, to follow the principles of the agile approach, the researcher presupposed no predetermined scheme and design to eliminate any biased development in this phase. Hence, after considering the findings of the qualitative phase and developing the first version of the app, it was delivered to the participants; they utilized and delved into VG to provide the researcher with their feedback. Afterward, the researcher considered the received feedback and developed the next iteration/increment; these iterations and

increments continued until the end of the study. The development process consisted of several iterations, not a single shot process; hence, each part functioned as a standalone module, which was the base of the next increment. Next, to shed more light on how this procedure was fulfilled, an instance of the tool integration process is discussed.

In the current study, first based on the semi-structured interview (see appendix D), the analyses of the participants' feedback and the emerged themes shown in Table 2, the fundamental building blocks of the app were defined. For instance, the participants' desire to interact with the other classmates to practice the learned vocabulary, was mapped into the facets of the task model. According to the facets of the task model, shown in figure 1, this desire was mainly related to the tool facet of the task model, since based on the semi-structured interview, the rest of the components including the subject (the participants themselves), control (free to interact), context ( the community of classmates), communication (cooperation), and the objective (practicing the learned vocabulary) were already apparent. Next, the researcher, following the principles of agile methodology, used multiple resources such as the related literature, the experts, and the available tools in the market. Then, based on his own expertise and experience as an IT specialist and mobile application developer, the researcher selected a chat tool as the appropriate choice for the situation. Therefore, the implementation and integration of the chat module were carried out, and finally, the new version of VG was released to get the feedback of the participants for probable further modifications.

During another meeting, the needs analysis evoked the necessity of taking notes by the students. Then, after mapping the necessity to the facets of the task model, the researcher pinpointed the importance of integrating a note-taking tool within VG. Following the principles of agile methodology, the researcher referred to multiple resources and finally used his tact and expertise to implement the software codes to add a note-taking module to VG. In the

last phase, the new version was released to find out any necessary alteration based on the participants' feedback.

Although agility is the fundamental principle of the agile approaches, discipline is also a necessity for making a successful endeavor; hence, in the current study, there was a balance between these two essential principles. Also, planning was less formal and open to new findings and feedback; during the development process, any necessary technological advancement, which was found useful, was employed to elevate the functionality of the final product. Finally, since the developed module and system of the app worked well together, it was clear that the decisions were made correctly.

## Discussion

In today's broad penetration of mobile technologies into various aspects of human life as everyware (Criollo-C et al., 2018; Greenfield, 2010; Rossing et al., 2012), developing and utilizing mobile apps is not a matter of choice anymore. Since every individual, or group of individuals, have their unique attributes and objectives, customizing the required app and gearing it to the objectives and settings of the target person or group is of utmost importance. The English language is a lingua franca (Bowles & Cogo, 2016; Jenkins & Leung, 2017), and vocabulary is one of the essential aspects of language learning (Golaghaei, 2019; Laufer, 2014; Paribakht & Wesche, 1997), and a fundamental aspect of language use (Schmitt, Cobb, Horst, & Schmitt, 2017; Schmitt & Schmitt, 2020). Nevertheless, the researcher of the current study could not find any mobile application which had been developed based on the target users' needs analysis. Therefore, in contrast with the previous projects, and to cover the pedagogical needs and necessities of a specific academic situation, the researcher developed and customized VG for the target EFL learners, by making mold on the task model (Taylor et al., 2006), and following the principles of agile methodology (Chande & Flora, 2013; Dingsøyr et al., 2012; Sharma et al., 2012).

Developing each iteration of the app, the researcher reconsidered the app features based on the feedback received from the learners. Since delivering content via the other means is possible, using a mobile app should include features that are either not possible without it or hard to achieve. According to Heil et al. (2016), the present vocabulary mobile applications fail to provide a motivating environment based on the learners' needs analysis. Whereas considering particularities of a given pedagogical setting according to the learners' personal preferences, not only provokes deep reflection, and critical thinking (Barjesteh, 2019; Cahyani, 2019; Fahim, Barjesteh, & Vaseghi, 2012; Frohberg et al., 2009) but also fosters cooperation and communication among learners and developers (Huang, 2019). Hence, contrary to the observed studies, these aspects were critically considered before developing any iteration of VG.

Also, as reported by Burston (2015), the designs of 291 MALL studies, included in his investigations, were not adequate to consider various variables involved. There was too much focus on technological issues rather than the needs or necessities of the learning processes. Burston and Athanasiou (2020), in their comprehensive overview of MALL projects considering 2000 MALL studies, from 1994 to 2018, reaffirmed the severe design flaws, and virtually lack of any sort of interpersonal communication among learners, whereas, these aspects were considered and implemented during VG life cycle. Therefore, unlike the previous studies, during the agile process of the current app development, the users had different facilities such as chatrooms, forums, email services, as well as online chat with the researcher to cooperate and communicate to get across their expectations and share their experiences. Also, in contrast to the studies mentioned above, which provided no practical self-assessment tool, every new learning experience was followed by an online quiz resulting in automatic and immediate feedback. The learners could try the contextualized quizzes as many times as they wish until they get to their desired outcome. Furthermore, they could communicate and talk about

the vocabulary they had learned on/offline in forums or chatrooms; whereas in the other observed studies, only email services were used to a limited extent, but the rest of the above-mentioned communicative features were not utilized via the apps (Foomani & Hedayati, 2016; Malekzadeh & Najmi, 2015; Rahimi & Miri, 2014; Samaie et al., 2018).

## Conclusions and Implications

In the current study, a custom-made vocabulary mobile app, called VG, was developed based on a critical investigation following the principles of post-method (Kumaravadivelu, 2003, 2006), and the dimensions of the task model introduced by Frohberg et al. (2009), to teach English vocabulary to intermediate Iranian EFL learners. The model and the framework of the VG life cycle is rooted in an adapted agile approach (Asfour et al., 2019; Jabangwe, Edison, & Duc, 2018). Therefore, in the current study, the researcher being a TEFL and IT specialist, developed VG through multiple iterations and adjustments, considering learners' feedbacks gathered before, during, and after the app implementation.

The mutual communication and cooperation among the learners, and with the researcher, during the life cycle of VG, kept transparency of the process of learning and the relevant objectives, without any learner's disorientation. Accordingly, the synergistic impact of all the participants kept the learners motivated and up-to-date regarding their objectives; in this regard, learners reported their satisfaction and progress via email, in the forum posts or chat rooms, and also, during face to face meetings. Further analysis is required to quantify the impact of using VG on the learners' knowledge of vocabulary. Also, only vocabulary recognition and recall were addressed by the quizzes in VG, although the learners were encouraged to learn the other aspects of vocabulary such as pronunciation, and using vocabulary in their sentences. Since the agile methodology is based on needs analysis and necessities of situations, because no learners asked for pronunciation and production

assessments to be included in quizzes, and also due to time limitations (12 academic sessions), these aspects were not implemented in the app quizzes. Of course, these features can be assessed/self-assessed in the quizzes of the next versions of VG if the necessity arises and pushes forward the agile life cycle of guru to settle down in a new attractors basins as is mentioned by De Nicola et al. (2020), Harshbarger (2007), and Larsen Freeman (2012).

The life cycle of VG, elaborated on in the current paper, provides insightful implications for vocabulary specialists, teachers, educators, app developers, and pedagogical foundations involved in or considering the design, development, and implementation of mobile apps by critically analyzing the unique needs of the target population in an interactive dynamic, agile life cycle. Post-method educators may also find implications, in the current study, regarding actualizing their theories, via MALL, according to the unique needs and necessities of their pedagogical settings. Finally, utilizing the developed app (i.e., VG), via experimental studies, yields in implications regarding the impacts of using a custom-made mobile app on EFL learners' knowledge of vocabulary in an academic context.

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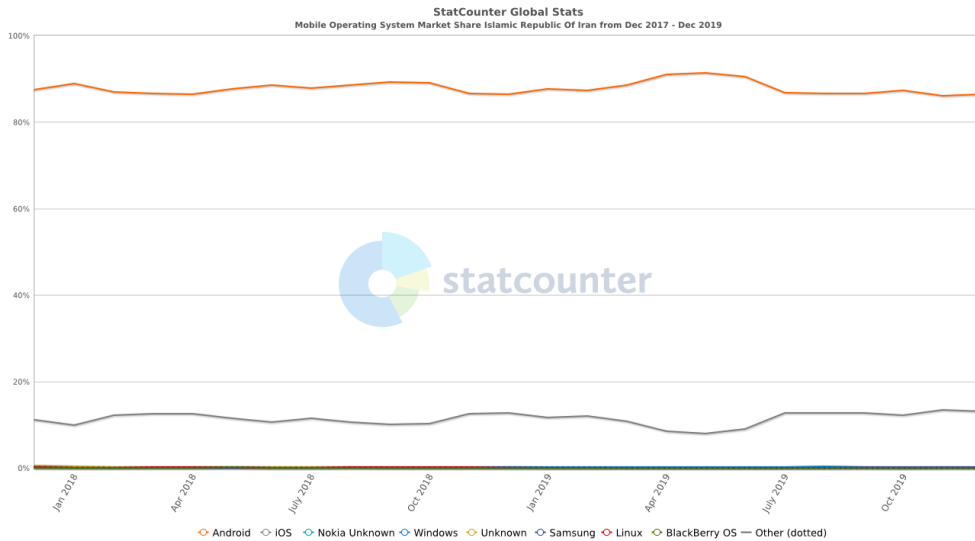Zhang, H. (2018). A literature review and meta-analysis of digital games and second language learning. *Major Papers, 33*. Retrieved from https://scholar.uwindsor.ca/major-papers/33/

**Appendix A**
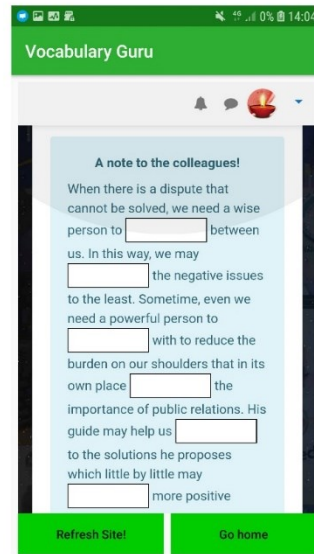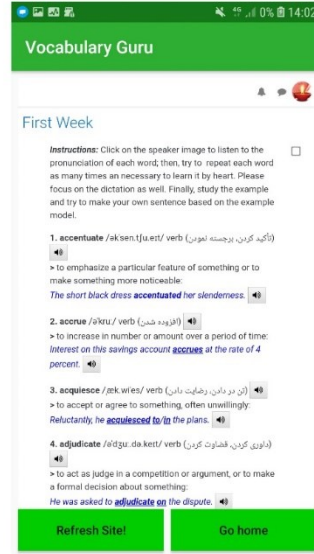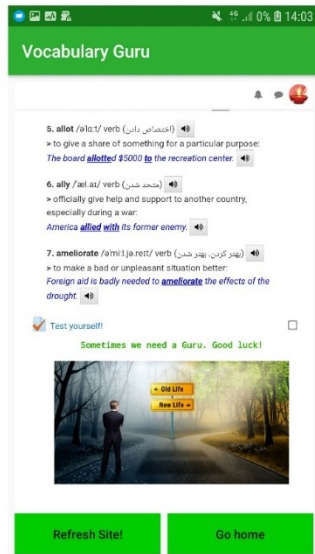**Mobile Operating System Market Share by Net MarketShare Website**
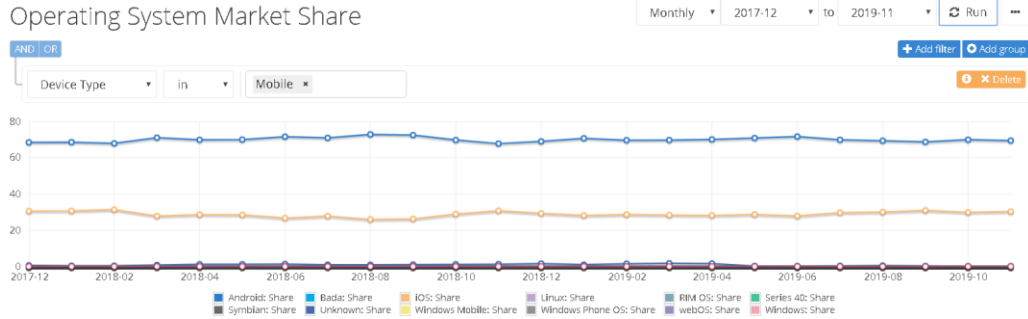


**Appendix B**
**Mobile Operating System Market Share by Statcounter Website**

**Appendix C**
**VG Interface: A Sample Lesson and the Relevant Quiz**

**Appendix D**
**Main Questions of the Semi-Structured Interview**

1. How do you prefer to learn vocabulary: explicit versus implicit? (i.e., Do you prefer to learn vocabulary deductively starting from learning definitions, parts of speech, usage, and use, and then practice them in the context of the situation, or you prefer not to focus on these aspects and just acquire them via immersion as you have been exposed to your mother tongue? (Sobczak & Gaskell, 2019)

2. What are the advantages of learning vocabulary via mobile apps to your belief?

3. What aspects of vocabulary knowledge (e.g., meaning, part of speech, knowledge of morphology, socio-pragmatics, or other aspects) do you expect to learn via a mobile app designed for teaching vocabulary?

4. What is your idea about communication and cooperative learning via a mobile app?

5. What type of help or support do you expect to be available via a mobile vocabulary app? (For example, web-based, teacher/peer-oriented, or other types of support)

6. Do you like to share your idea and experience during learning, or you prefer to do it all by yourself?

7. How do you usually learn vocabulary? Do you write them, read them loudly, ...?

8. Do you prefer to learn the meaning of vocabulary in context, or you prefer to memorize a list of words without any context?

9. What kind of facilities/tools (e.g., notepads, dictionaries, pronunciation checkers, games, or other facilities.) do you need/expect to find in a mobile app designed for teaching vocabulary?

10. What is your idea about using your mother tongue (L1) in the process of vocabulary learning (e.g., bilingual guides, L1 equivalents, and alike)?

11. What do you suggest for customizing an app for learning vocabulary? (Anything which may not be addressed in the questions mentioned above.)

# Appendix E
## The Qualitative Map of the Processed Data Generated by MAXQDA