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# A SMARTPHONE APPLICATION FOR LEARNING ARABIC VOCABULARY: A COMPREHENSIVE SYSTEMATIC REVIEW

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**Abstract:**

The drastic technological advancement has paved the way for innovative approaches to language learning, with smartphone applications emerging as powerful tools in education. This systematic review explores the design and evaluation of a smartphone application that enhances Arabic vocabulary acquisition. Numerous language learning applications exist. Nevertheless, a gap exists in the literature regarding the specific design elements and evaluation criteria tailored for Arabic vocabulary acquisition. This review addresses the lack of a consolidated understanding of the challenges and opportunities in developing a smartphone application dedicated to learning Arabic vocabulary. This comprehensive systematic review explores the design and evaluation of smartphone applications dedicated to enhancing Arabic vocabulary acquisition, employing advanced search techniques on Scopus and Eric databases with keywords “smart phone,” “Arab,” and “vocabulary.” The flow of the study is based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The final primary data (n = 28) articles were identified, clustering around three main themes: (1) Language Skills and Comprehension in Bilingual Contexts, (2) Technology and Language Learning, and (3) Corpus and Text Analysis. This systematic review contributes to the academic discourse by highlighting the current landscape and paving the way for future research in the dynamic intersection of technology and Arabic language education. This systematic review sheds light on the current landscape of smartphone applications designed for learning Arabic vocabulary. The findings from this review are expected to inform

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educators, developers, and policymakers, ultimately contributing to improving Arabic language education through innovative technological solutions.

**Keywords:**

Smartphone, Arab, Vocabulary

## Introduction

In the dynamic landscape of language education, technological innovations have ushered in transformative changes, offering novel avenues for language acquisition (Ali et al., 2021; Khairul Asyraf, Mohd Sukki, Wan Muhammad, & Nik Farhan, 2017; Nathir, Othman, Sulong, & Mustafa, 2017b, 2017a). As the demand for efficient and accessible language learning tools continues to rise, smartphone applications have emerged as promising platforms for fostering linguistic proficiency (Keogh et al., 2019; Kim et al., 2016; Mi, Cavuoto, Benson, Smith-Jackson, & Nussbaum, 2014; Rodriguez-Sanchez, Moreno-Alvarez, Martin, Borromeo, & Hernandez-Tamames, 2014). This article embarks on a journey of exploration, presenting a systematic review that meticulously scrutinizes the design and evaluation of smartphone applications tailored for learning Arabic vocabulary.

Being among the languages that are most broadly spoken globally, Arabic presents a unique linguistic landscape marked by its rich cultural heritage and historical significance (Al-Jumaily, Martínez, Martínez-Fernández, & Van der Goot, 2012; Larabi Marie-Sainte, Alalyani, Alotaibi, Ghouzali, & Abunadi, 2019; Rofik, 2021). However, the complexity of Arabic vocabulary, characterized by its intricate script and diverse linguistic nuances, often poses challenges for learners (Hasan & Najim, 2020; Nashwan, Rashwan, Al-Barhamtoshy, Abdou, & Moussa, 2018; Oudeh, 2021). Recognizing the need for tailored language learning solutions, researchers and educators have increasingly turned to smartphone applications, leveraging the ubiquitous nature of these devices to enhance the accessibility and effectiveness of language education (Abebe et al., 2019; Al-Khaibri, 2022; A. Nasir, 2020).

The main objective of this systematic review is to offer a comprehensive overview of the existing landscape of smartphone applications designed for Arabic vocabulary acquisition. Note that our analysis extends beyond a mere compilation of available apps. Instead, it scrutinizes their design principles, pedagogical methodologies, and the efficacy of their evaluation frameworks. Furthermore, by adopting a systematic approach, we aim to distil key insights, identify trends, and evaluate the overall quality of existing applications, thereby informing the design and enhancement of future tools.

The systematic review encompasses a broad spectrum of criteria, including but not limited to adaptability, user interface design, interactivity, and learner engagement. Through the synthesis of empirical studies, user reviews, and comparative analyses, we seek to unravel the strengths and weaknesses of current applications, shedding light on the elements that contribute to or hinder effective Arabic vocabulary acquisition.

As educators, researchers, and developers navigate the intersection of language learning and technology, this systematic review serves as a critical resource, offering evidence-based insights that can guide future advancements in smartphone application design. Thus, by distilling the collective wisdom embedded in the current landscape, we strive in contributing

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to the ongoing discourse on innovative language learning solutions, facilitating informed decisions for educators and learners in their pursuit of Arabic language proficiency.

## Literature Review

The following is a literature review of previous studies related to Arabic vocabulary learning applications.

The first study (Ali et al., 2021) discusses an interactive app called "Understand My World", which allows children to learn new vocabulary in Arabic in an interactive as well as independent way using tablets or smart phones. The app utilizes a camera and microphone to scrutinize the world, understand spoken words as well as read written language properly. Children may also speak into their devices to record and listen to their own speech. The app then presents the dictated words in both spoken and written formats. The application is intentionally designed to be user-friendly and smooth in operation, making it appealing to children who would like to learn through multimedia.

The second study (Al-Janaideh, Hipfner-Boucher, Cleave, & Chen, 2022) evaluates the content and level of vocabulary learning game applications for young children's language learning on smartphones and tablet PCs. The study analyzes 30 English and 30 Korean word game applications using a software evaluation instrument and mobile content evaluation criteria modified to consider the developmental characteristics of young children. The results show that the educational value of the games received the highest score in all evaluation areas, but the design received the lowest score. The English word game applications received higher scores in all areas than the Korean word game applications.

The third study (Herawati & Ainil Mawaddah, 2023) examines the language of utilizing word-by-word translations of the Qur'an to help students learn Arabic and increase their vocabulary. The study uses a literature review approach to examine the acquired data. The findings show that using word-by-word translations of the Qur'an helps students understand Arabic terms more efficiently, which improves their ability to memorize and use Arabic vocabulary. However, relying only on translation may reduce students' overall knowledge of Arabic and develop dependency on translation. Thus, the accurate and apparent usage of word-by-word Qur'an translations is critical to preserving students' comprehensive understanding of Arabic.

The fourth study (Luo & Li, 2018) analyzes the current design of English language learning applications and discusses the advantages as well as disadvantages of the methods which are used. The study intends to create a new online application based on smart phones and apply the new concept to improve English language learning. The paper presents a novel design strategy that incorporates situated learning to add new functionality to existing apps. The study shows each element of the new application and finds that the usage of contextual learning opens doors to opportunities, innovatively modifying the way students learn.

The fifth study (Wenyuan, 2017) reviews the existing literature on mobile-assisted language learning (MALL) research on vocabulary, especially smartphones. It explores an effective mode to apply vocabulary learning as well as teaching in Chinese colleges. The study discusses how mobile learning transforms traditional classroom-based teaching and learning (T&L), bridging both formal and informal learning. As vocabulary learning is a difficult part of English learning, the study explores an effective mode to apply vocabulary T&L in Chinese colleges.

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In conclusion, the studies reviewed show that there are various approaches to Arabic and English vocabulary learning applications, including interactive apps, word-by-word translations, and situated learning. These studies provide insights into the design and evaluation of vocabulary learning applications and can be useful for developing effective applications for Arabic and English vocabulary learning.

## Material And Methods

### *Identification*

Several key steps in the systematic review process were used to select a great deal of relevant literature for this study. First, keywords are selected, then related terms are searched using dictionaries, thesaurus, encyclopedias, and past research. All relevant terms were established once the search strings for the Eric as well as Scopus databases were formed (refer to Table 1). Here, during the first stage of the systematic review process, 1,213 publications were successfully extracted from both databases for the current study project.

**Table 1: The Search String.**

| | |
|---|---|
| **Scopus** | TITLE-ABS-KEY ((app* OR "smart phone") AND arab* AND (vocabulary OR dictionary)) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2023)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (LANGUAGE, "English")) |
| **Eric** | app* OR "smart phone") AND arab* AND (vocabulary OR dictionary) |

### *Screening*

The first step entails scrutinizing a collection of potentially related research items to locate information that answers predefined research questions. During this screening phase, content-related criteria are important. This includes selecting research items using a smartphone application designed for learning Arabic vocabulary. Consequently, duplicate papers are systematically eliminated from the initially retrieved papers. The first screening stage excluded 994 publications, and in the subsequent stage, 219 papers underwent evaluation based on distinct exclusion as well as inclusion criteria outlined in Table 2. Additionally, the primary criterion employed in this process is examining literature, encompassing research papers, reviews, book series, meta-analyses, books, meta-syntheses, chapters, as well as conference proceedings, which are not covered in the most current study. Moreover, the review solely focused on English publications, with the timeframe limited to 2020-2023. It is crucial to note that one publication was rejected based on duplication criteria.

**Table 2: The Selection Criterion Is Searching**

| **Criterion** | **Inclusion** | **Exclusion** |
|---|---|---|
| **Language** | English | Non-English |
| **Timeline** | 2020-2023 | < 2020 |
| **Literature type** | Journal (Article) | Conference, Book, |
| **Publication Stage** | Final | In Press |

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***Eligibility***

In the third phase, known as eligibility, a complete set of 218 articles was collected. During this stage, all articles' titles and important content were meticulously reviewed to ensure adherence to inclusion criteria and fit with the current study aims. Consequently, 160 reports were excluded due to reasons such as being outside the scope, lacking a significant title, having an abstract unrelated to the study's objectives, and lacking full-text access. The final outcome of this screening process yielded 55 articles eligible for review (refer to Figure 1).

***Data Abstraction and Analysis***

Among the assessment procedures employed in this research was an integrative analysis, which examined and analyzed a number of research approaches (quantitative methods). The competence study aimed to find relevant subjects and subtopics. Data collection was the first phase in the theme's development. Here, Figure 1 depicts how the authors methodically assessed a collection of 55 publications for assertions or material related to the current research issues. The authors then evaluated the current significant studies on smartphone applications for learning Arabic vocabulary. The methods employed in all studies, including their research findings, were reviewed. Similarly, the author worked with other co-authors to establish themes based on the findings in this study's context. Via the data analysis process, a log was kept to record any analyses, perspectives, riddles, or other data interpretation-related thoughts. Lastly, the writers evaluated the findings to identify any inconsistencies in the theme design process. Note that if the authors disagree on any of the concepts, they discuss them amongst themselves. The patterns created were eventually altered to guarantee consistency. To determine the integrity of the problems, two specialists in Arabic language education and Arabic e-learning selected them for analysis. The expert review phase guarantees that each subtheme is clear, important as well as appropriate by determining domain validity.

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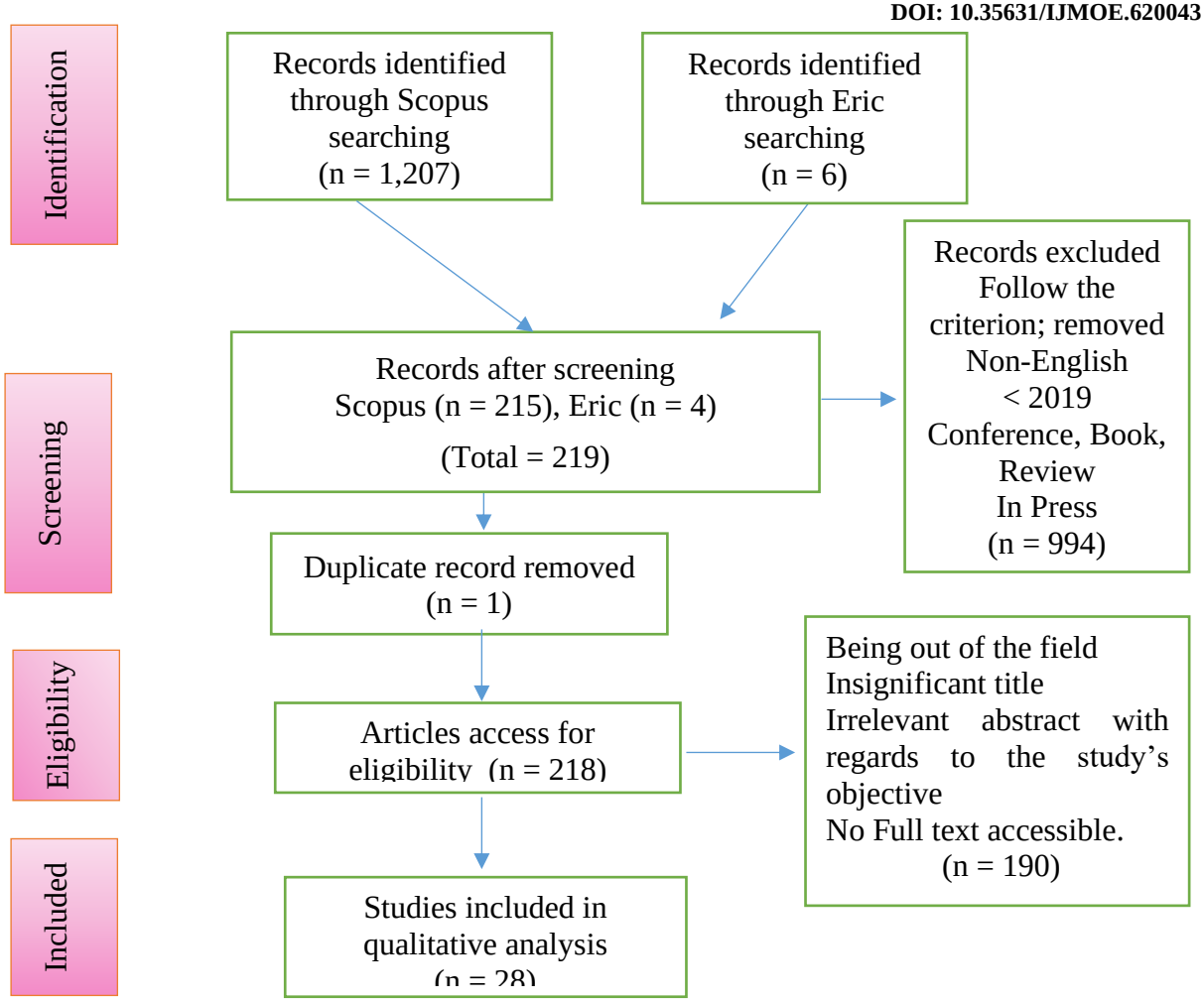


**Figure 1: Flow Diagram Of The Suggested Search Study (Keogh et al., 2019)**

**Result and Finding**

Designing and evaluating a smartphone application for learning Arabic vocabulary is crucial in today's educational landscape. The process involves user-centered design principles, understanding the target audience through surveys or interviews, and incorporating interactive content such as gamification and multimedia elements. The curriculum should cover essential Arabic vocabulary topics with a structured progression, and a tracking system should enable users to monitor their progress. Furthermore, multilingual support, pronunciation practice, and cultural context are integral features, while accessibility and inclusivity ensure a diverse user base. At the same time, regular assessments, user feedback mechanisms, and continuous updates are essential for app effectiveness. The application should be optimized for various platforms, ensuring responsive design for different screen sizes. In essence, a successful Arabic vocabulary learning app is user-friendly, culturally relevant, and adaptable, with ongoing improvements based on user input and evolving educational methodologies. Accordingly, 28 articles have been extracted as well as analyzed.

All articles have been classified relying on three main themes, which include language skills as well as comprehension in bilingual contexts (10 articles), technology and language learning (10 articles), and corpus and text analysis (8 articles) (see Table 3).

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**Table 3: The Research Article's Findings Based On The Proposed Search Criterion**

**Language Skills and Comprehension in Bilingual Contexts**

| Authors | Title | Year | Journal | Methodology | Finding and Advantages |
|---|---|---|---|---|---|
| Al-Janaideh et al. (2022). | Contributions of code-based and oral language skills to English and Arabic reading comprehension in Arabic-English bilinguals in the elementary school years | 2022 | International Journal of Bilingual Education and Bilingualism | The assessment likely involved evaluations of word reading, receptive vocabulary, narrative comprehension, as well as narrative production, though specifics are not specified. | The study validated the simplistic view of bilingual children's reading comprehension in both English as well as Arabic, indicating that narrative production predicts English reading comprehension and vowelized word reading. |
| Alothman and Wahab Sait (2022) | Managing and Retrieving Bilingual Documents Using an Artificial Intelligence-Based Ontological Framework | 2022 | Computational Intelligence and Neuroscience | The study utilized data extraction methodology, bilingual dictionary development, Naïve Bayes classifier, and link analysis ranking approach for data analysis. | The suggested ontological framework outperformed the existing framework in managing bilingual documents. |
| Khosravi and Chalechale (2022) | Recognition of Arabic/Persian Handwritten Words Using a Combination of Convolutional Neural Networks and Autoencoder (AECNN) | 2022 | Mathematical Problems in Engineering | The study focused on word decomposition, sign extraction, dictionary development, classifier training using CNNs and AE networks, and proposing a subword fusion algorithm. | The proposed method outperformed other methods in the literature with a recognition accuracy of 91.09%. |

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| Authors | Title | Year | Journal | Methodology | Finding and Advantages |
|---|---|---|---|---|---|
| Koulali and Koulali (2023) | Feature Selection as a Hedonic Coalition Formation Game for Arabic Topic Detection | 2023 | Pattern Recognition Letters | The study proposed a novel feature selection method utilizing the Hedonic Coalition Formation Game, described topics with unique Topic Oriented Vocabulary (TOV) vectors, evaluated performance on Arabic corpora, and compared it with MI-based methods. | The proposed method effectively generates new vocabularies with highly discriminating features as well as reduced dimensions. |
| Shakil, Tabassum, Alqahtani and Wani (2021) | Analyzing user digital emotions from a holy versus non-pilgrimage city in Saudi Arabia on the Twitter platform | 2021 | Applied Sciences (Switzerland) | The project involved collecting geolocated tweets, classifying emotions using Plutchik's categories, and designing Arabic English Emotion Lexicon (AEELex) for emotion determination. | Mecca residents exhibited higher positivity, with anticipation being the dominant emotion in both areas, with a larger proportion present in Mecca. |
| Cherifi and Guerti (2021) | Arabic grapheme-to-phoneme conversion based on joint multi-gram model | 2021 | International Journal of Speech Technology | The Joint Multi-Gram Model (JMM) is a probabilistic method used to estimate the likelihood of a particular event. | The results are not as promising as the baseline, but they are promising with a 10% error rate on phoneme transcription. |
| Berrichi and Mazroui (2021) | Addressing Limited Vocabulary and Long Sentences Constraints in English–Arabic Neural Machine | 2021 | Arabian Journal for Science and Engineering | The study utilized factored NMT models with morphosyntactic features and sentence segmentation techniques using lexical | The translation quality has significantly enhanced in comparison to the basic NMT system. |

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| Authors | Title | Year | Journal | Methodology | Finding and Advantages |
|---|---|---|---|---|---|
| | Translation | | | markers and the SMT system. | |
| Uni (2022) | Benefits of Arabic Vocabulary for Teaching Malay to Persian-speaking University Students | 2022 | Eurasian Journal of Applied Linguistics | The study conducted a vocabulary survey consisting of 40 Malay words with Arabic origins, providing an explicit demonstration of their word origins. | Participants achieved an average of 19.9 correct answers, with a significant improvement observed after explicit demonstration (p = .000). |
| Alsharhan and Alnajem (2021) | Developing a Stress Prediction Tool for Arabic Speech Recognition Tasks; [ بر في الكلمات لأنظمة تطوير أداة لتمييز مواضع النعلى الكلام العربيّف الآليّالتعر] | 2021 | Scientific Journal of King Faisal University Basic and Applied Sciences | The tool for stress prediction and phonetic transcription has been developed and assessed in an automatic speech recognition system. | The study discovered a 5.6% reduction in WER with stress markers on stressed syllable phones and a 3.5% reduction with markers only on stressed vowels. |
| Altakhaineh, Sulaiman and Alhendi (2021) | Teaching English Grammatical Collocations to Arabic-Speaking EFL Learners | 2021 | International Journal of Technologies in Learning | The study involved 40 EFL tenth-grade students, divided into a treatment group using overhead projectors and a control group using printed dictionaries, and conducted a pre-test and delayed post-test. | Overhead projector and guessing games improved collocation learning compared to printed dictionaries, with noun + preposition collocations being the most challenging due to vocabulary and L1 transfer. |
| Shannaq, Hammo, Faris and Castillo-Valdivieso | Offensive Language Detection in Arabic Social Networks Using Evolutionary-Based | 2022 | IEEE Access | The two-stage optimization strategy required fine-tuning pre-trained word embedding models in the | Utilizing Aravec SkipGram word embedding, the SVM method accomplished 88.2% of accuracy and an F1-score of 87.8% on the |

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|---|---|---|---|---|---|
| (2022) | Classifiers Learned From Fine-Tuned Embeddings | | | first stage, followed by a hybrid approach that combined XGBoost as well as SVM classifiers with a genetic algorithm in the second. | ArCybC dataset. |
| Moser (2021) | Evaluating Arabic textbooks: A corpus-based lexical frequency study | 2021 | International Journal of Applied Linguistics (United Kingdom) | The study employed a corpus-based approach, utilizing lexical frequency analysis, MADAMIRA morphological analyzer, and AntWordProfiler to compare vocabulary vowelled and lemmatized words. | The study revealed a low number of items in each frequency band in textbooks, indicating potential lexical gaps. |
| Saleh and Ahmed Althaqafi (2022) | The Effect of Using Educational Games as a Tool in Teaching English Vocabulary to Arab Young Children: A Quasi-Experimental Study in a Kindergarten School in Saudi Arabia | 2022 | SAGE Open | A quasi-experimental study in Saudi Arabia involved 40 young Arab learners aged 5-6, using educational games and traditional repetition, and assessed through pre-test, post-test, as well as delayed post-test. | Educational games enhance learner engagement, enhance knowledge absorption and retention, and offer practical application experiences. |
| Alwehebi and Ghareeb (2021) | Strategies for second language learning in EFL textbooks of Saudi high school: A content analysis | 2021 | Journal of Language and Linguistic Studies | The study analyzed the content of three units from each of six 'Mega Goal' EFL textbooks. | The textbooks lack an explicit presentation of Language Learning Strategies (LLS), with vocabulary strategies being implicit and reading and writing |

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| | | | | | strategies found in language activity instructions. |
| Alwakid et al. (2022) | MULDASA: Multifactor Lexical Sentiment Analysis of Social-Media Content in Nonstandard Arabic Social Media | 2022 | Applied Sciences (Switzerland) | The MULDASA algorithm used emojis, intensifiers, negations, and nonstandard expressions to analyze sentiments in multilingual sentiment LX, utilizing stemming and feature-sentiment correlation procedures. | The Arabic sentiment analysis project demonstrated improved accuracy from 83.84% to 89.80% in opinion classification, surpassing previous projects using a lexical approach. |
| Ahsanuddin et al. (2022) | Building a Corpus-Based Academic Vocabulary List of Four Languages | 2022 | Pegem Egitim ve Ogretim Dergisi | The corpus was developed using the IDM ADDIE framework and constructed using a PHP script. | A 377880 tokens corpus as well as five sub-corpora was created for language teacher education, confirming its integration feasibility and enhancing students' vocabulary through the DDL approach. |
| Almusharraf (2021) | Perceptions and application of learner autonomy for vocabulary development in Saudi EFL classrooms | 2021 | International Journal of Education and Practice | The study involved a qualitative case study, semi-structured interviews with eight students, classroom observations, participant reflections, and English learning autobiographies. | The study highlighted the positive impact of autonomous learning methods on students' English language appreciation, highlighting the development of self-possession, self-confidence, as well as positive learning outcomes. |

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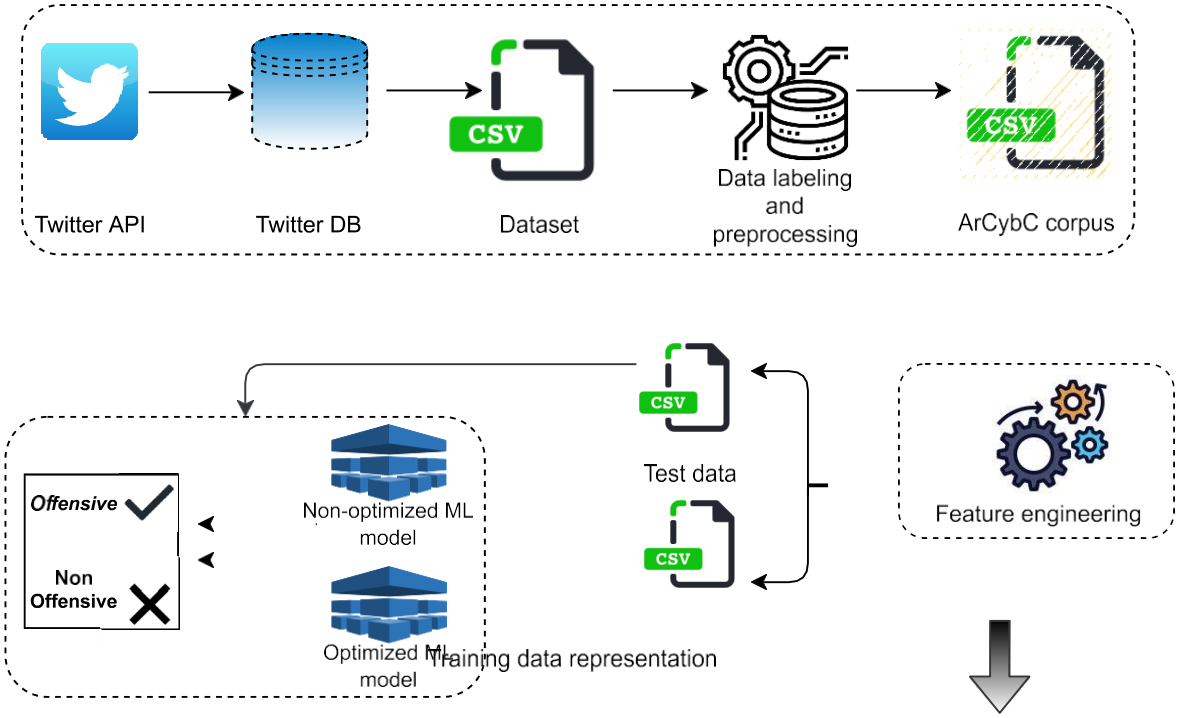


**Figure 2: The Architecture Of The Offensive Language Detection Approach (Shannaq et al., 2022)**

**Technology and Language Learning**

| Authors | Title | Year | Journal | Methodology | Finding and Advantages |
|---|---|---|---|---|---|
| Li (2021) | Search query of English translation text based on embedded system and big data | 2021 | Microprocessors and Microsystems | The study explored CLIR methods, including machine translation, detection methods, dictionary translation, as well as Arabic-to-English translation, while also | The proposed model improves Arabic-to-English translation accuracy by addressing OCR errors, resolving ambiguities, and expanding |

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| | | | | managing OCR errors and expanding and transliterating names for disambiguation. | single questions with additional meanings and related words. |
| Yassin and Abugohar (2022) | GAMIFIED MOBILE-ASSISTED FORMATIVE ASSESSMENT FOR REVIVING UNDERGRADUATE LEARNERS' OVERALL LANGUAGE PROFICIENCY: A QUASI-EXPERIMENTAL STUDY | 2022 | Teaching English with Technology | The MALL technique, a quasi-experimental design, was used in formative assessment using mobile apps like Kahoot and Quizizz, with pre-and post-tests and two cycles over 14 weeks. | The Oxford Placement Test (OPT) suggested that mobile-assisted formative assessment using Kahoot and Quizizz significantly improved students' overall language proficiency. |
| Sahrim, Soad and Asbulah (2023) | Augmented Reality Technology in Learning Arabic Vocabulary from the Perception of University Students | 2023 | International Journal of Interactive Mobile Technologies | The study collected data from 30 USIM respondents using questionnaires, conducted descriptive statistical analysis, and used Cronbach's alpha for internal consistency. | The majority of students expressed satisfaction and positive perceptions about using augmented reality (AR) in Arabic language learning, with a mean score of 4.48. |
| . Alethary, Aliwy and Ali (2022) | Automated Arabic-Arabic sign language translation system based on 3D avatar technology | 2022 | International Journal of Advances in Applied Sciences | The project involved creating an ArSL dictionary with 3,000 signs using eSign editor software, developing a translator, and evaluating it using the METEOR metric with an 86% relative score. | The ArSL machine translation system was successfully developed, achieving an 86% evaluation score. |
| Elleuch, Gargouri and Ben Hamadou | Lexical data mining-based approach for the self-enrichment of LMF | 2021 | Concurrency and Computation: | The study involved lexical data mining of textual content in normalized LMF | The LMF lexical entries have been successfully enhanced with advanced |

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| (2021) | standardized dictionaries: Case of the syntactico-semantic knowledge | | Practice and Experience | dictionaries, enriching syntactic behaviors, semantic classes as per Gaston Gross's classification, and establishing syntactico-semantic links. | syntactic and semantic knowledge. |
| Solimando (2022) | E-Learning and Arabic in the Age of Covid-19: Rethinking the Learning of Vocabulary | 2022 | Altre Modernita | The MOODLE platform is used for language learning, with a weekly vocabulary-building challenge and a learner-centred methodology, ensuring teacher oversight. | The MOODLE glossary effectively aided in Arabic vocabulary learning, fostering independent learning and involving student participation in its creation. |
| Nasir, Brahin, Ariffin, Mispan and Wahab (2023) | AI Educational Mobile App Using Deep Learning Approach | 2023 | International Journal on Informatics Visualization | The application development process utilized Android Studio and Tensorflow, with Convolution Neural Network (CNN) for image classification, pre-training of thousands of images, and integration of interactive elements. | The application achieved over 90% accuracy in image classification, offering children an interactive and engaging learning experience, successfully integrating deep learning into vocabulary learning. |
| Brahin, Nasir, Jidin, Zulkifli and Sutikno (2020) | Development of vocabulary learning application by using machine learning technique | 2020 | Bulletin of Electrical Engineering and Informatics | The application development process utilized Android Studio and TensorFlow object detection API, incorporating machine learning techniques for accurate prediction and interactive elements for enhanced learning experience. | The "LearnWithIman" application has been successfully implemented, with accurate image predictions aiding language learning and positive feedback on its interactive and playful features. |

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| Zibin, Altakhaineh, Suleiman and Al Abdallat (2023) | The Effect of Using an Arabic Assistive Application on Improving the Ability of Children with Autism Spectrum Disorder to Comprehend and Answer Content Questions | 2023 | Journal of Psycholinguistic Research | The study involved questionnaires for caregivers and ASD specialists, focus-group discussions with teachers, a pre-test comprised of 55 content questions, a three-week treatment using the Aseel app as well as a post-test for evaluation. | The Aseel app has revealed substantial differences in pre- and post-test answers among non-verbal and verbal children with ASD, potentially aiding in learning complicated Arabic content questions. |
| Van Der Zwaan, Latif, Van Kuppevelt, Lyklema and Lange (2021) | Are you sure your tool does what it is supposed to do? Validating Arabic root extraction | 2021 | Digital Scholarship in the Humanities | The study validated three Arabic root extraction tools, Khoja, ISRI, and AlKhalil, and manually annotated gold standard data from Islamic jurisprudence books. | Khoja was selected as the optimal root extraction tool for the provided data, but variations in individual root counts among tools led to varying interpretations. |


**Figure 3: Mobile Cloud Computing (MCC) Architecture (Brahin et al., 2020)**

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**Corpus and Text Analysis**

| Authors | Title | Year | Journal | Methodology | Finding and Advantages |
|---|---|---|---|---|---|
| Koulali and Koulali (2023) | Feature Selection as a Hedonic Coalition Formation Game for Arabic Topic Detection | 2023 | Pattern Recognition Letters | Created TOV vectors for each topic by formulating feature selection using a Hedonic Coalition Formation Game. | The proposed Hedonic game approach effectively generated vocabularies with highly discriminating features as well as reduced dimensions. |
| Shakil et al. (2021) | Analyzing user digital emotions from a holy versus non-pilgrimage city in Saudi Arabia on the Twitter platform | 2021 | Applied Sciences (Switzerland) | The study analyzed Arabic geolocated tweets from Mecca and Riyadh, classified user emotions using Plutchik's eight categories, and designed and validated the AEELex. | Mecca residents exhibited greater positivity than Riyadh residents, with anticipation being the dominant emotion in both cities, with a higher proportion in Mecca. |
| Elleuch et al. (2021) | Lexical data mining-based approach for the self-enrichment of LMF standardized dictionaries: Case of the syntactico-semantic knowledge | 2021 | Concurrency and Computation: Practice and Experience | The study involved lexical data mining of textual content in normalized LMF dictionaries, enriching syntactic behaviours with suitable meanings, enriching meanings with semantic classes using Gaston Gross classification, and establishing syntactico-semantic links. | The self-enrichment of dictionaries has led to improved lexical entries, enhanced semantic classes, syntactic behaviors, as well as syntactico-semantic links, thereby enhancing the coverage of lexical knowledge. |
| Moser (2021) | Evaluating Arabic textbooks: A corpus-based lexical frequency study | 2021 | International Journal of Applied | The study employed a corpus-based approach, using lexical frequency | The textbooks have identified a low number of items at each frequency band, |

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| Authors | Title | Year | Journal | Methodology | Finding and Advantages |
|---|---|---|---|---|---|
| | | | Linguistics (United Kingdom) | analysis, MADAMIRA morphological analyzer, and AntWordProfiler to compare vocabulary vowelled and lemmatized words to the first 3,000 most frequent words. | indicating gaps in lexical coverage. |
| Alwehebi and Ghareeb (2021) | Strategies for second language learning in EFL textbooks of Saudi high school: A content analysis | 2021 | Journal of Language and Linguistic Studies | The content analysis is based on Chamot and Schmitt's lists of learning strategies, including vocabulary, reading, and speaking/writing strategies. | The textbooks lack an explicit presentation of Language Learning Strategies (LLS), and instead, they implicitly use vocabulary, reading, and writing strategies discovered in language activity instructions. |
| Alwakid et al. (2022) | MULDASA: Multifactor Lexical Sentiment Analysis of Social-Media Content in Nonstandard Arabic Social Media | 2022 | Applied Sciences (Switzerland) | The MULDASA algorithm used emojis, intensifiers, negations, and nonstandard expressions to create a simple stemming procedure for root word association and feature-sentiment correlation to exclude irrelevant viewpoints. | The method has enhanced sentiment classification accuracy from 83.84% to 89.80%, enhancing precision in opinion classifications by incorporating diverse linguistic elements. |
| Ahsanuddin et al. (2022) | Building a Corpus-Based Academic Vocabulary List of Four Languages | 2022 | Pegem Egitim ve Ogretim Dergisi | The corpus development process utilized the IDM ADDIE framework and | A 377,880 tokens corpus as well as five sub-corpora has been confirmed for |

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|---|---|---|---|---|---|
| | | | | PHP language, with expert and student evaluations being conducted. | integration into learning, proving helpful for students in expanding vocabulary through a DDL approach. |
| Almusharraf (2021) | Perceptions and application of learner autonomy for vocabulary development in Saudi EFL classrooms | 2021 | International Journal of Education and Practice | The study utilized a qualitative approach, including face-to-face semi-structured interviews, classroom observations, participant reflections, and English learning autobiographies. | Students appreciated that the English language and autonomous learning methods enhance self-possession, self-confidence, and positive learning outcomes. |

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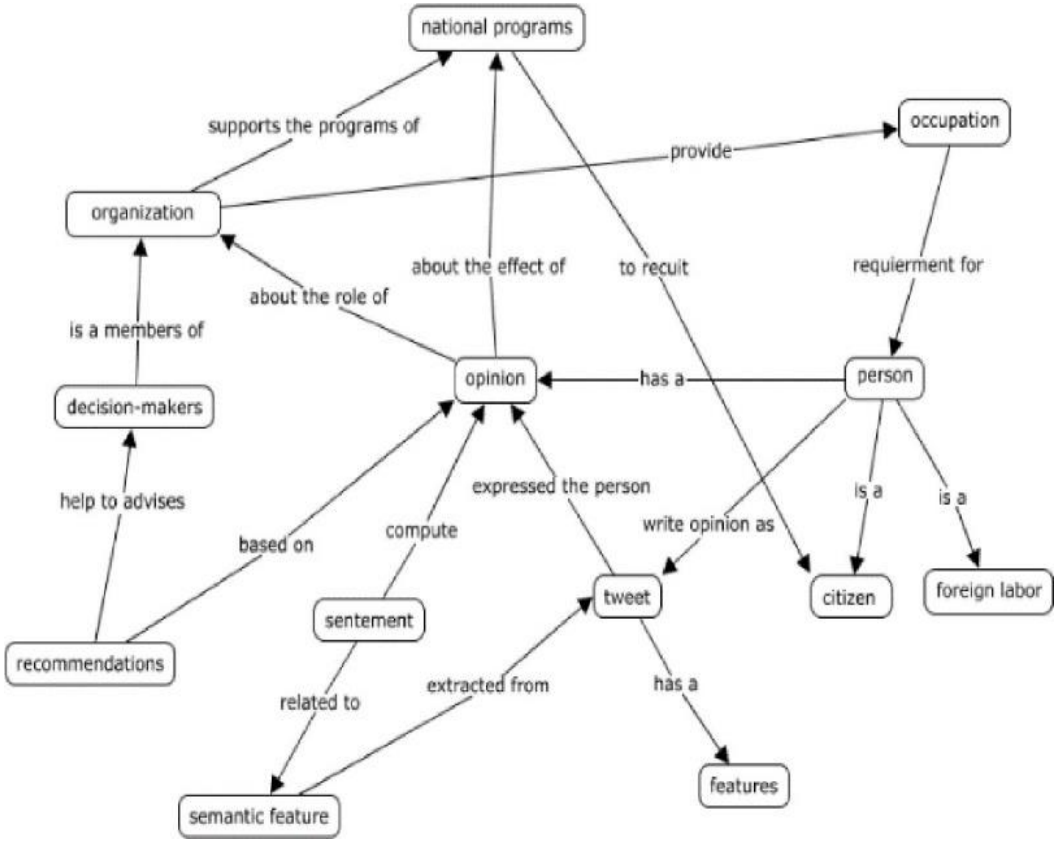


**Figure 4: Concept diagram (Alwakid et al., 2022)**

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## Discussion and Conclusion

In conclusion, the given text covers various topics such as reading comprehension, bilingual documents, recognition accuracy, vocabulary generation, emotions in Mecca, phoneme transcription, translation quality, explicit demonstration, reduction in WER, collocation learning, word embedding, lexical gaps in textbooks, educational games, language learning strategies, sentiment analysis, corpus creation, and autonomous learning methods. Each topic presents its own findings and improvements, contributing to the overall understanding and advancement in the respective fields.

In conclusion, the text highlights various successful implementations and developments in language learning technologies. This includes Arabic-to-English translation models, mobile-assisted formative assessment, augmented reality, machine translation systems, lexical entries, glossaries, image classification applications, and learning apps. These technologies have demonstrated positive outcomes in improving language proficiency and vocabulary learning as well as aiding in the learning process for both verbal as well as nonverbal children with ASD. Additionally, the text mentions the importance of selecting appropriate tools for root extraction to ensure accurate interpretations.

The key argument of the paper is that the suggested Hedonic game approach effectively generates vocabularies with highly discriminating features as well as reduced dimensions, resulting in improved lexical entries and increased lexical knowledge coverage. Furthermore, diverse linguistic elements have enhanced sentiment classification accuracy, and incorporating autonomous learning methods has had positive student learning outcomes.

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