SIAKAD machine learning for correcting errors in speaking Arabic

Mahyudin Ritonga [*] Muhammadiyah University of West Sumatra, Faculty of Islamic Studies, Arabic Language Education Study Program, Jl. Pasir Kandang No. 4 Padang, Indonesia https://orcid.org/0000-0003-1397-5133

Zulmuqim Zulmuqim, State University of Imam Bonjol Padang, Faculty of Tarbiyah and Education Training, Islamic Education Department, Islamic, Indonesia https://orcid.org/0000-0002-6819-6754

Bambang Bambang, Muhammadiyah University of West Sumatra, Faculty of Islamic Studies, Arabic Language Education Study Program, Padang, Indonesia https://orcid.org/0000-0002-9435-1009

Rahadian Kurniawan, Institute Agama Islam Negeri Curup, Faculty of Tarbiyah and Education Training, Arabic Language Education Department, Indonesia https://orcid.org/0000-0002-5796-3751

Pahri Pahri, Islamic Higher Education, Arabic Language Education Study Program, Shalahuddin Al-Ayyubi, Jakarta, Indonesia https://orcid.org/0000-0001-6838-4723

Abstract

Information technology provides a lot of convenience for humans in completing their tasks and getting results according to targets. In line with that, language teachers have a duty to find out the level of language skills and forms of language errors in students. Machine Learning as part of technology can be maximized to detect forms of Arabic speaking error in students. This study was conducted with a qualitative approach. Data were collected via SIAKAD machine learning containing Arabic videos. Based on the results, the SIAKAD machine learning uncovered several Arabic speaking errors such as grammar, pronunciation, shifat al-huruf, vowels, word expression, and concatenated sentences. Therefore, machine learning with various types can be maximized in Arabic learning which ultimately leads to technological developments that must be accompanied by the ability of teachers to be skilled in operationalizing technology.

Keywords: Arabic Language Education; Machine Learning; Speaking Errors

[*] ADDRESS OF CORRESPONDENCE: Mahyudin Ritonga, Muhammadiyah University of West Sumatra, Faculty of Islamic Studies, Arabic Language Education Study Program, Jl. Pasir Kandang No. 4 Padang, Indonesia
Email address: mahyudinritonga@gmail.com / Tel +6281365540404

1. Introduction

Current technological developments actually make it easier for humans to complete their tasks and responsibilities. This view is based on the use of technology which also cannot be separated from the various types of technological devices available. Technology in relation to human work facilitates the completion of work, maximizes work results, and streamlines time (Parry & Battista, 2019; Beer & Mulder, 2020; Johnson et al., 2020). Therefore, every aspect of human life today requires technology as well as education.

In the field of education, technological developments can be seen in learning platforms, learning media, and learning resources. Various articles related to Information and Communication technology are often found as a combination of audio/data, video/data, audio/video, and internet technologies. Related to the explanation above, Arabic teachers need information related to technology that can be used to detect Arabic speaking errors in students.

Students at various levels of education in Indonesia are faced with the problem of achieving language skills. Among the Arabic language skills that students must achieve in learning Arabic as a foreign language (AFL) are speaking skills *(maharah kalam).* Solyman and colleagues based on their study found that the errors in Arabic were in the grammatical aspect (Solyman et al., 2022). Al-Qaraghuli et al assert that correcting language errors using machine learning is very effective (Al-Qaraghuli et al., 2021).

1.1. Conceptual or Theoretical Framework

Machine learning (ML) is one part of artificial intelligence (artificial intelligence) (Helm et al., 2020). Machine learning adheres to the concept of forming machines as intelligent systems like humans in general (Heuer et al., 2021; Zhai et al., 2021). However, in this case, intelligence is created using a learning and training process first, before the system is carried out in the real world ((Xia et al., 2021; Perno et al., 2022). Thus, all its activities will be easily recognized, understood, and carried out properly, effectively, and efficiently (Puspitarini & Hanif, 2019). Machine learning is also part of a discipline that includes the design and development of algorithms that allow computers to develop behavior based on empirical data, such as sensor data.

Machine learning is a knowledge-based system that is loaded into the system so that the machine can make decisions from the input data provided to determine the validity of the letters and listen to the pronunciation of the letters (Agarwal et al., 2021). Input data for machine learning from the push-on switch used is the MTS tactile switch (Rao et al., 2021), the output display on the graphic LCD is for viewing the letters, and the sound output for the speakers is for listening to the pronunciation of the letters. Machine learning also provides testing facilities to determine the extent of students' knowledge in recognizing letters (Settles et al., 2020; Xu et al., 2019). The testing facility is that children pronounce the letters displayed on the machine via the LCD, later the machine will correct whether the pronunciation is right or wrong. In the testing facility using the pattern recognition method (pattern recognition) (Lopes et al., 2017), which will be applied to this application is a field in machine learning and can be interpreted as the act of taking raw data and acting on data classification. This pattern recognition can be interpreted as a classification process of objects or patterns that aim to make decisions.

The use of machine learning is now being developed by higher education institutions in Indonesia (Ho et al., 2021), by giving names such as the Academic Information System (SIAKAD) (Putri, 2013). One of the development directions is the ability of machine learning in correcting errors in speaking Arabic (*maharah kalam*) (Solyman et al., 2021) through a computerized system. The presence of machine

learning as part of technological development is expected to be able to overcome the problems that arise in the error correction process of *maharah kalam*.

Errors that occur during the learning process of *maharah kalam* are part of the problems contained in the study of Arabic learning (Zurqoni et al., 2020). Errors in *maharah kalam* usually appear in the phonological aspects, sounds, and sentence structure in Arabic (Zulharby et al., 2019). *Maharah kalam* is the ability to express articulation sounds or words to express thoughts in the form of ideas, opinions, desires, or feelings to the interlocutor (Musthofa & Rosyadi, 2020), because speaking is a system of signs that can be heard and seen that utilizes a number of body muscles. humans to convey thoughts in order to meet their needs.

The presence of machine learning as an assessment medium for correcting Arabic speaking errors has received serious attention from scholars, academics and researchers. This is evidenced by the large amount of literature that discusses the topic as an output of scientific research. As the results of Alenezi and Faisal research show that machine learning is part of learning that makes it easy for teachers to correct students' learning processes during the study (Alenezi & Faisal, 2020). The results of Souad's study explain that machine learning algorithms in the Arabic learning process have a very high level of accuracy, this is supported by the robustness of the data used and the ease of operation (Larabi Marie-Sainte et al., 2019).

Another study from Kanan describes that Arabic is an international language that is widely used globally, its complex characteristics make Arabic difficult to detect through computers, but through machine learning it plays a very important role in helping to understand textual data content (Kanan et al., 2019). More interestingly, Ibrahim's findings confirm that Arabic speaking skills through social media with high hate speech are found in various regions in Arabia, therefore the researchers chose the machine learning method as a medium to analyze hate speech by speakers using Arabic on social media (Aljarah et al., 2020). Finally, Ahmed et al research results support the use of machine learning as an Arabic learning machine to make it easier for teachers and tutors to assess the level of difficulty faced by students when learning Arabic (Ahmed et al., 2019).

1.2. Related Research

A study by (Ross et al., 2019) focused on the use of the Web Speech Recognition API for the development of practical communicative language learning. The developed website gives students the opportunity to receive real-time feedback regarding the targeted language. The website also opens opportunities for students to practice speaking outside of study time. All student utterances, transcriptions, and scores associated with the tool are saved to a database for analysis.

Pikhart (2020) confirmed that artificial intelligence or machine learning is based on the human ability to use it so that it can be useful as needed (Pikhart, 2020). Wu and Zheng (2021) conducted a study related to the trend of using machine learning in the learning process which led to a drastic increase and proved to be very effective (Wu & Zheng, 2021).

Meanwhile, a study related to Arabic speaking errors was carried out by Akbari on analyzing language errors in Arabic grammar where many students have not been able to apply grammar in Arabic orally (Akbari, 2018). Abdualzhraa et al (2018) concluded that errors in English syntax are sometimes caused by L1 differences in students (Abdoualzhraa Yaseen et al., 2018). Khalid et al conducted a study on semantic errors in translating Arabic sentences into Indonesian. The study was limited to a description of each language error (Khalid et al., 2021).

1.3. Purpose of the Study

Based on the results of previous studies, the researcher said that this study became a fundamental discussion in the scientific realm of learning Arabic, especially in speaking skills (*maharah kalam*). Because, this study tries to complete the lack of research that has been done before. The purpose of this study is to identify errors in speaking Arabic through the SIAKAD machine learning method which is a technology-based learning medium in universities. Specifically, the study aims to:

1. Explain carefully and precisely the use of SIAKAD as machine learning in Arabic learning, especially in speaking skills

2. Find some forms of Arabic speaking errors and describe the forms of these errors.

2. Method and Materials

The research was conducted with a qualitative approach, this is due to the researcher's desire to find forms of errors that occur in student communication in Arabic using SIAKAD, not revealing the percentage in each aspect. The study was conducted on students of the Muhammadiyah University of West Sumatra who attended the *maharah al-kalam*. Data were collected through observations of students who communicated using Arabic at SIAKAD, the results of the observations were then documented in observation notes to avoid losing research data. The research time is for 1 full semester, which is 14 (fourteen) meetings.

The data collected during the lecture was then analyzed by revealing the forms of Arabic communication errors that occurred in students. In the analysis, the impact that occurs due to communication errors is explained by explaining the possibilities that students must do based on theories that have been standardized in communicating using Arabic and using technology as a medium to improve Arabic language skills. The analysis was carried out with the help of VOSViewer which was useful for mapping the results of other people's research related to the forms of errors in communicating Arabic.

2.1. Research Model

This study used a qualitative descriptive approach by describing the facts that occurred without any treatment. This approach was chosen to uncover the forms of Arabic speaking errors found through machine learning.

2.2. Participants

This study involved 18 students enrolling the "Maharah al-Kalam" course at Arabic Language Education Study Program Universitas Muhammadiyah Sumatera Barat. All informants provided video recordings of Arabic conversations at each meeting. Therefore, the material for this study were Arabic video recordings sent by students to SIAKAD with a total of 14x18: 252 (two hundred and fifty-two) videos with a duration of 2-3 minutes.

2.3. Data Collection Tools

This study used Nvivo 12 to find data in the form of Arabic errors from the video.

2.4. Data Collection Process

Data collection was carried out in accordance with the rules and code of ethics applicable in Indonesia. Data were collected at every meeting of the "Maharah al-Kalam" course. Each student must send the video recording no later than the end of the meeting.

2.5. Data Analysis

The data were analyzed interactively since the data collection process and the process took place during the implementation of the study.

To facilitate researchers in obtaining data from various library sources, researchers used Perish or Publish and Vosviewer. Perish or Publish was used to compile resources related to audiolingual methods in various publishers. Researchers determined keywords to facilitate the search for the required data. The use of Perish or Publish has been widely practiced by academics to find study data in the form of literature reviews (van Dalen, 2021; Dani, 2018; Herndon, 2016). The data collected were then visualized with Vosviewer to find themes and researchers related to the study.

3. Results

3.1 SIAKAD as Machine Learning Tool in Maharah Kalam Course

The unsafe conditions from the COVID-19 outbreak are a consideration for university management to carry out online learning. Therefore, teachers and students set an agreement on the use of SIAKAD as a platform for the continuity and smoothness of the learning process.

On the other hand, these policies and agreements are not beneficial in achieving learning objectives, such as learning Arabic speaking skills (maharah kalam). The maharah kalam course requires students to hear, see and practice directly how the teachers say L2. The data relating to the use of SIAKAD as Machine Learning in the Maharah Kalam Course can be seen in table 1 below:

Table 1. SIAKAD as Machine Learning in Maharah Kalam Course

No	Indicators of Arabic Speaking Skills	Student Perception on SIAKAD as a Platform
1	SIAKAD helps students speak fluent Arabic	In general, students show difficulties in speaking Arabic
2	Have skills in choosing the right diction in the spoken sentence	Maharah kalam course using SIAKAD has not helped students to be proficient in choosing the right diction in the spoken sentence. Their vocabulary is very limited, the placement of words in sentences is stagnant.
3	Skilled in using grammar when speaking Arabic	Grammar is used appropriately, but creativity in expressing various patterns of Arabic sentences is very limited
4	Spoken language using proper reasoning	Students who learn maharah kalam using SIAKAD as a machine learning tool have not been able to use the right language with logic.
5	Spoken language in harmony with body language	In the video uploaded to SIAKAD, it can be seen that the body language of students is not in harmony with the meaning of the language spoken

orally.

Table 1 above shows that students enrolling in the maharah kalam course with the SIAKAD platform as a machine learning tool are faced with several problems related to Arabic speaking competence. These data indicate that the use of SIAKAD as a machine learning tool requires development, both in terms of developing user capabilities and improving the quality of SIAKAD as a machine learning tool.

3.2 Arabic Speaking Errors Based on SIAKAD Machine Learning

Based on the video uploaded by students to SIAKAD, it can be illustrated that the forms of errors can be shown in table 2 below:

Table 2. Arabic Speaking Errors Based on SIAKAD Machine Learning

No	Language Element	Description of Spoken Error
1	Phonetics	In the videos uploaded by students, there are language errors in phonetic aspects, such as errors in makharij al-letter, line errors, recitation errors and intonation.
2	Morphology	Students are still wrong in choosing the form of the word (shighat) spoken, as well as the choice of words that should be commensurate with ruba'i majid expressed in the form of tsulatsi majid. Errors like this are often found in videos uploaded by students via SIAKAD as a machine learning tool.
3	Syntax	Many of the sentence patterns used by students in spoken language are not in accordance with Arabic grammar
4	Semantics	The choice of relevant words for the sentences expressed sometimes does not clearly mean the desired meaning, so that listeners often get the wrong understanding

Based on the data described in table 2 above, SIAKAD as a machine learning tool found several Arabic speaking errors according to the video uploaded by students. Spoken language errors cover all aspects such as phonetics, morphemic, syntax, and semantics.

4. Discussion

SIAKAD at the Muhammadiyah University of West Sumatra is an academic system built with features that must be used by lecturers and students in every lecture. For matters related to academics, students and lecturers can use SIAKAD for various activities, such as attendance input, attendance printing, material content, material uploads, discussions up to the final assessment stage of each course and feedback in the form of student satisfaction questionnaires to lecturers. The description above can be described as in the image below:

Login tool

Option on system
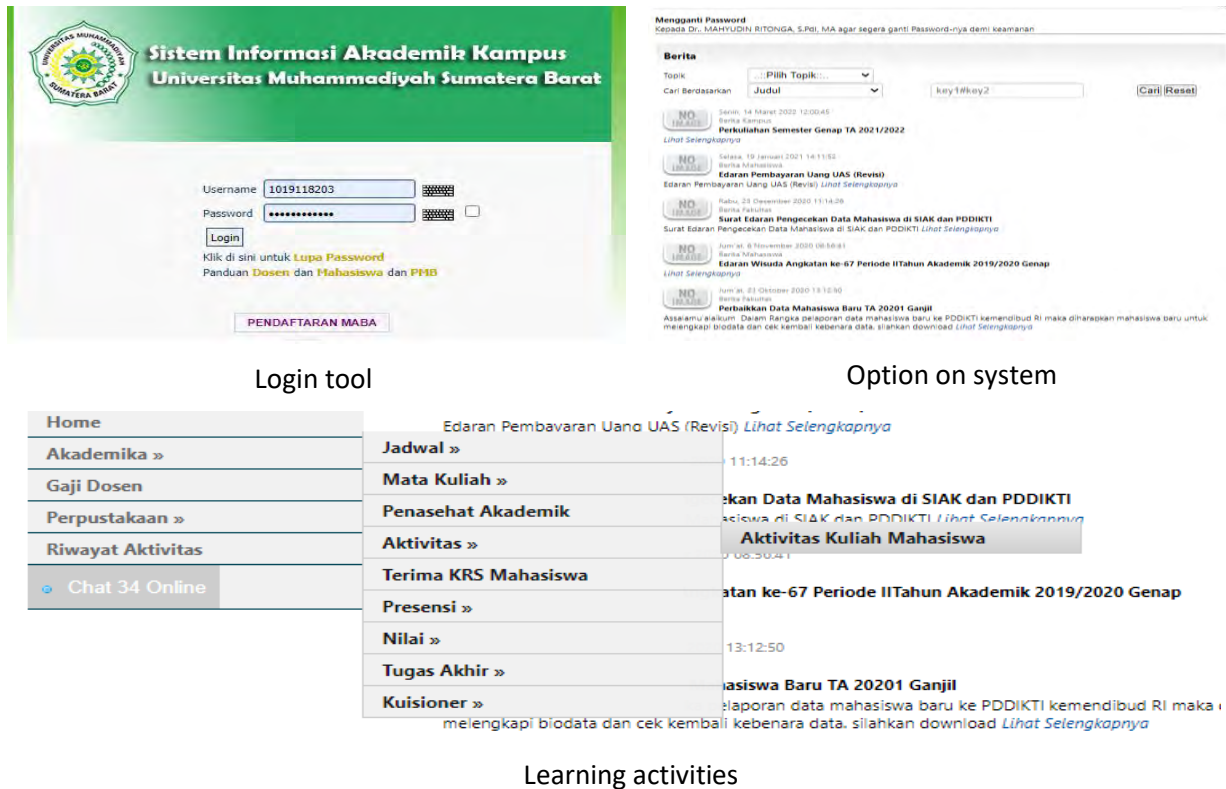
Learning activities

Figure 1. Description of University SIAKAD

For those related to Arabic error correction through University SIAK, it can be done in the discussion menu and upload Video. At each implementation of the *maharah al-kalam* students are given the obligation to upload videos in the form of recordings of their conversations using Arabic. From the results of observations of videos uploaded by students at SIAKAD, it can be explained that the aspects of errors that occur in Arabic communication are as shown in the diagram below:
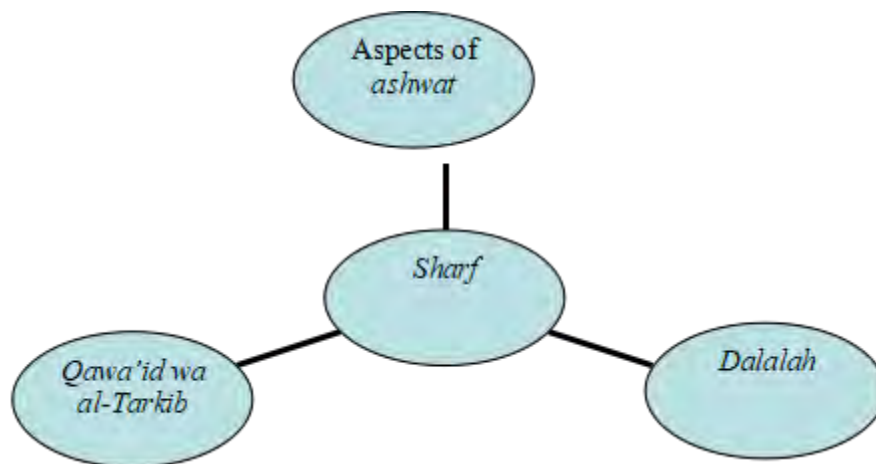

Figure 2. Forms of Communication Errors.

In accordance with the data in Figure 2 above, the Arabic communication errors found through SIAKAD can be grouped into four broad lines, namely aspects of *ashwat, Sharaf, Qawa'id wa al-Tarkib and Dalalah.* In the *ashwat* aspect, as found in the videos uploaded by students, there are errors in

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terms of *makhraj, shifat al-huruf, mad wa al-Qashar.* This error is evenly distributed in videos uploaded by students, and this data shows that students still have difficulty in achieving internal skills. Errors in the makhraj for example, there are data that reveal the letter with the letter when lining up at the *katsrah* and *dommah.* The exchange of letter sounds in Arabic often causes a change in meaning (Abd Elwahab, 2020). Another error in the phonetic aspect as in the data obtained through SIAKAD is that students often make mistakes in the form of vowels, vowels in Arabic include *fathah, kasrah, dommah, fathatayn, kasratayn, dhommatyn* (Abu-Rabia, 2019); (Mitleb, 1984); (Abu-Rabia & Saliba, 2008).

Another error in communicating Arabic that is found in SIAKAD is in the *sharf* or morphology aspect of the Arabic language. Arabic morphology is part of the language elements that must be known and studied by students. Because with a correct understanding of the morphology of the Arabic language, it will be able to bring up a large vocabulary (Safrullah et al., 2021), this does not only happen in Arabic but also in various languages in the world (Ali Jassem, 2015); (Gayo & Widodo, 2018). The data obtained from the SIAKAD Machine Learning shows that the form of speech errors from the morphological aspect of Arabic is expressing the form of the word which should be *fi'il madhi* but is expressed in the form of *fi'il mudhari',* there are also student conversations that should be expressed in the form of fa'il but expressed in the form of *maf'ul.*

The results of the analysis of students' speaking errors using machine learning SIAKAD also contain errors from the *qawa'id wa al-tarkib* aspect, the meaning here is that there are students who are wrong in placing the position of the word in the sentence expressed. Grammatical errors in language have a broad impact on the meaning of language (Khalid et al., 2021); (Atashian & Al-Bahri, 2018); (Mamnunah et al., 2021), this problem will lead to the non-delivery of the desired message, both by listeners and speakers. Another error found through the SIAKAD Machine Learning in communicating with students' Arabic is that there is an inaccuracy in choosing the pair of words in the sentence expressed, therefore the researcher categorizes this error as part of a *dalalah* or semantic error.

Four categories of students' Arabic errors found through SIAKAD Machine Learning during the 2021/2022 odd semester lectures on aspects of phonology, morphology, syntax and grammar as well as semantics, when analyzed using VOSViewer can be described as in Figure 3 below:

Figure 3. Language Error Research by VOSviewer Analysis

Figure 3 above, it can be emphasized that communication errors occur among students and foreign language users. And the error aspect is found in the elements of phonology (Purnama et al., 2019), morphology (Shamsan & Attayib, 2015), syntax/grammar and semantics (Mohammad, 2015). Students' speaking errors in Arabic as found through the SIAKAD machine learning have relevance to the various research results mentioned above, the basic difference is in the foreign language being studied, this finding is important because each language has its own character and characteristics, both from the phonological aspect, morphology, syntax and semantics.

Another difference that can be highlighted in this study is the tool for measuring language errors. If some existing studies detect language errors through conceptual analysis of linguistic theory, then this research is to prove the existence of SIAKAD as machine learning can be used as a tool to measure students' Arabic communication errors.

5. Conclusion

According to the data and analysis described above, it can be concluded that SIAKAD as machine learning can be maximized to find out students' communication language errors. Educators can do this by instructing students to upload video conversations that they previously recorded at SIAKAD. The recording results are then analyzed for various aspects of the errors that occur, according to the findings of this study during the odd semester 2021/2022 lectures can be categorized that errors that occur in student Arabic communication are in the phonological, morphological, syntactic/grammatical and semantic aspects of Arabic.

SIAKAD as a machine learning tool has not succeeded in improving the Arabic speaking skills of students. As the data explained and discussed, it shows that students have not been helped by the maharah kalam course using SIAKAD as a platform. Students also have not been helped in choosing the

right diction to use in sentences, reasoning does not develop, and spoken language is also not in harmony with body language.

6. Recommendations

Based on the results, Arabic learning in terms of speaking skills using the SIAKAD machine learning can take place with various limitations because there are still Arabic speaking errors. Therefore, the following suggestions need to be considered:

1. Arabic learning in the current technological era should utilize various devices and platforms according to the material and learning objectives.

2. The practice of listening and speaking using Arabic through technological devices must be familiarized, this is intended to minimize language errors that occur among students.

3. This study is faced with several limitations, therefore further researchers can develop studies related to machine learning specifically in relation to Arabic learning.

References

Abd Elwahab, W. (2020). The Effect of Local Arabic Dialects on Learning English Language Pronunciation. *Arab World English Journal*, *11*(1), 489–499. https://doi.org/10.24093/awej/vol11no1.33

Abdoualzhraa Yaseen, A., Ismail, K., & Subakir Mohd Yasin, M. (2018). Syntactic Errors in an Arab EFL Postgraduate Student's Spoken English during a Thesis Supervision Session. *Arab World English Journal*, *9*(4), 392–406. https://doi.org/10.24093/awej/vol9no4.29

Abu-Rabia, S. (2019). The Role of Short Vowels in Reading Arabic: A Critical Literature Review. *Journal of Psycholinguistic Research*, *48*(4), 785–795. https://doi.org/10.1007/s10936-019-09631-4

Abu-Rabia, S., & Saliba, F. (2008). The lexical status of basic Arabic verb morphemes among dyslexic children. *Australian Journal of Learning Difficulties*, *13*(2), 115–144. https://doi.org/http://dx.doi.org/10.1080/19404150802380589

Agarwal, A., Sharma, P., Alshehri, M., Mohamed, A. A., & Alfarraj, O. (2021). Classification model for accuracy and intrusion detection using machine learning approach. *PeerJ Computer Science*, *7*(e437), 1–22. https://doi.org/10.7717/PEERJ-CS.437

Ahmed, M. A., Hasan, R. A., Ali, A. H., & Mohammed, M. A. (2019). The Classification of the Modern Arabic Poetry Using Machine Learning. *Telkomnika (Telecommunication Computing Electronics and Control)*, *17*(5), 2667–2674. https://doi.org/10.12928/TELKOMNIKA.v17i5.12646

Akbari, M. Y. A. (2018). Arabic Error Analysis. *1st International Conference on Intellectuals' Global Responsibility (ICIGR 2017)*, *125*(Icigr 2017), 168–171. https://doi.org/10.2991/icigr-17.2018.41

Al-Qaraghuli, M., Abandah, G., & Suyyagh, A. (2021). Correcting Arabic Soft Spelling Mistakes Using Transformers. *2021 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT)*, 146–151. https://doi.org/10.1109/JEEIT53412.2021.9634142

Alenezi, H. S., & Faisal, M. H. (2020). Utilizing Crowdsourcing and Machine Learning in eEducation: Literature Review. *Education and Information Technologies*, *25*(4), 2971–2986. https://doi.org/10.1007/s10639-020-10102-w

Ali Jassem, Z. (2015). The Arabic Cognates or Origins of Plural Markers in World Languages: a Radical Linguistic Theory Approach. *Indonesian EFL Journal*, *1*(2), 144–163. https://doi.org/https://doi.org/10.25134/ieflj.v1i2.623

Aljarah, I., Habib, M., Hijazi, N., Faris, H., Qaddoura, R., Hammo, B., Abushariah, M., & Alfawareh, M. (2020). Intelligent detection of hate speech in Arabic social network: A machine learning approach. *Journal of Information Science*, *47*(4), 483–501. https://doi.org/10.1177/0165551520917651

Atashian, S., & Al-Bahri, K. (2018). Towards Arab Students' Grammatical Errors in Academic Writing & their Perceptions. *Arab World English Journal*, *1*, 140–145. https://doi.org/10.24093/awej/mec1.10

Beer, P., & Mulder, R. H. (2020). The effects of technological developments on work and their implications for continuous vocational education and training: A systematic review. *Frontiers in Psychology*, *11*(May), 1–19. https://doi.org/10.3389/fpsyg.2020.00918

Dani, E. (2018). How "Publish or Perish" Can Become "Publish and Perish" in the Age of Objective Assessment of Scientific Quality. *Systemics, Cybernetics and Informatics*, *16*(4), 20–25. http://www.iiisci.org/Journal/PDV/sci/pdfs/IP052LL18.pdf

Gayo, H., & Widodo, P. (2018). An analysis of morphological and syntactical errors on the English writing of junior high school Indonesian students. *International Journal of Learning, Teaching and Educational Research*, *17*(4), 58–70. https://doi.org/10.26803/ijlter.17.4.4

Helm, J. M., Swiergosz, A. M., Haeberle, H. S., Karnuta, J. M., Schaffer, J. L., Krebs, V. E., Spitzer, A. I., & Ramkumar, P. N. (2020). Machine Learning and Artificial Intelligence: Definitions, Applications, and Future Directions. *Current Reviews in Musculoskeletal Medicine*, *13*(1), 69–76. https://doi.org/10.1007/s12178-020-09600-8

Herndon, N. C. (2016). Research Fraud and the Publish or Perish World of Academia. *Journal of Marketing Channels*, *23*(3), 91–96. https://doi.org/10.1080/1046669X.2016.1186469

Heuer, H., Jarke, J., & Breiter, A. (2021). Machine learning in tutorials – Universal applicability, underinformed application, and other misconceptions. *Big Data and Society*, *8*(1), 1–13. https://doi.org/10.1177/20539517211017593

Ho, I. M. K., Cheong, K. Y., & Weldon, A. (2021). Predicting Student Satisfaction of Emergency Remote Learning in Higher Education During COVID-19 Using Machine Learning Techniques. *PLoS ONE*, *16*(4 April), 1–27. https://doi.org/10.1371/journal.pone.0249423

Johnson, A., Dey, S., Nguyen, H., Groth, M., Joyce, S., Tan, L., Glozier, N., & Harvey, S. B. (2020). A review and agenda for examining how technology-driven changes at work will impact workplace mental health and employee well-being. *Australian Journal of Management*, *45*(3), 402–424. https://doi.org/10.1177/0312896220922292

Kanan, T., Sadaqa, O., Aldajeh, A., Alshwabka, H., Al-Dolime, W., Alzurbi, S., Elbes, M., Hawashin, B., & Alia, M. A. (2019). A Review of Natural Language Processing and Machine Learning Tools Used to Analyze Arabic Social Media. *2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology, JEEIT 2019 - Proceedings*, 622–628. https://doi.org/10.1109/JEEIT.2019.8717369

Khalid, S. M., Sanusi, A., Maulana, D., Tatang, T., & Al Farisi, M. Z. (2021). The Analysis of Semantic Grammatical Errors in Various Arabic Translations. *Arabi : Journal of Arabic Studies*, *6*(1), 15–25. https://doi.org/10.24865/ajas.v6i1.315

Larabi Marie-Sainte, S., Alalyani, N., Alotaibi, S., Ghouzali, S., & Abunadi, I. (2019). Arabic natural language processing and machine learning-based systems. *IEEE Access*, *7*, 7011–7020. https://doi.org/10.1109/ACCESS.2018.2890076

Lopes, A. T., de Aguiar, E., De Souza, A. F., & Oliveira-Santos, T. (2017). Facial Expression Recognition with Convolutional Neural Networks: Coping with Few Data and the Training Sample Order. *Pattern Recognition*, *61*(October 2017), 610–628. https://doi.org/10.1016/j.patcog.2016.07.026

Mamnunah, Abdurrahman, M., & Sopian, A. (2021). the Error Analysis of Arabic Grammar in the Kalamuna Book.

Arabi : Journal of Arabic Studies, *6*(2), 158–166. https://doi.org/https://doi.org/10.24865/ajas.v6i2.351

Mitleb, F. (1984). Vowel length contrast in Arabic and English: a spectrographic test. *Journal of Phonetics*, *12*(3), 229–235. https://doi.org/10.1016/s0095-4470(19)30879-4

Mohammad, T. (2015). Phonological, Morphological and Syntactical Influences of Mother Tongue on Arab Learners. *English Review: Journal of English Education*, *4*(1), 54–65. https://doi.org/10.25134/erjee.v4i1.307

Musthofa, T., & Rosyadi, F. I. (2020). Actualization of Behavioral Theory in Learning Arabic Speaking Skills at the Madrasah Aliyah Level. *Universal Journal of Educational Research*, *8*(12A), 7343–7349. https://doi.org/10.13189/ujer.2020.082518

Parry, E., & Battista, V. (2019). The impact of emerging technologies on work: a review of the evidence and implications for the human resource function. *Emerald Open Research*, *1*, 1–6. https://doi.org/10.12688/emeraldopenres.12907.1

Perno, M., Hvam, L., & Haug, A. (2022). Implementation of digital twins in the process industry: A systematic literature review of enablers and barriers. *Computers in Industry*, *134*, 103558. https://doi.org/10.1016/j.compind.2021.103558

Pikhart, M. (2020). Intelligent information processing for language education: The use of artificial intelligence in language learning apps. *Procedia Computer Science*, *176*, 1412–1419. https://doi.org/10.1016/j.procs.2020.09.151

Purnama, S., Farikah, Purwanto, B. E., Wardhani, S., Kholid, I., Huda, S., & Joemsittiprasert, W. (2019). The impact of listening phonological errors on speaking: A case study on english education. *Journal for the Education of Gifted Young Scientists*, *7*(4), 899–913. https://doi.org/10.17478/jegys.622005

Puspitarini, Y. D., & Hanif, M. (2019). Using Learning Media to Increase Learning Motivation in Elementary School. *Anatolian Journal of Education*, *4*(2), 53–60. https://doi.org/10.29333/aje.2019.426a

Putri, Y. R. (2013). The Effect of Web-Based Academic Information System Academic Service Quality at Communication Deparment of Telkom Institute of Management. *Jurnal Sosioteknologi*, *28*(12), 346–352. https://doi.org/10.5614/sostek.itbj.2013.12.28.7

Rao, A., Paradkar, A., Gupta, S., & Kadam, S. (2021). Inter-device Language Translation Application for Smartphones. In A. P. Pandian, R. Palanisamy, & K. Ntalianis (Eds.), *Proceedings of International Conference on Intelligent Computing, Information and Control Systems* (pp. 23–37). Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-15-8443-5_3

Ross, G., Henneberry, S., & Norris, G. (2019). Speaking With Your Computer: A New Way to Practice and Analyze Conversation. In R. Chartrand, E. Forsythe, A. B. Gallagher, D. Jarrell, & G. MacLean (Eds.), *AI and Machine Learning in Language Education* (pp. 152–167). Japan Association for Language Teaching (JALT) that. http://jaltcall.org/

Safrullah, D. Y., Sari, N. S. A., Julia, J., Ali, E. Y., & Widiawati, N. (2021). Cypriot Journal of Educational Enhancing students' understanding of Arabic syntax on high school students in Indonesia. *Cypriot Journal of Educational Sciences*, *17*(3), 702–718. https://doi.org/https://doi.org/10.18844/cjes.v17i3.6876 Received

Settles, B., Laflair, G. T., & Hagiwara, M. (2020). Machine Learning–Driven Language Assessment. *Transactions of the Association for Computational Linguistics*, *8*, 247–263. https://doi.org/https://doi.org/10.1162/tacl_a_00310

Shamsan, M. A.-H. A., & Attayib, A. (2015). Inflectional Morphology in Arabic and English: A Contrastive Study. *International Journal of English Linguistics*, *5*(2), 139–150. https://doi.org/10.5539/ijel.v5n2p139

Solyman, A., Wang, Z., Tao, Q., Elhag, A. A. M., Zhang, R., & Mahmoud, Z. (2022). Automatic Arabic Grammatical

Error Correction based on Expectation-Maximization routing and target-bidirectional agreement. *Knowledge-Based Systems*, *241*, 108180. https://doi.org/10.1016/j.knosys.2022.108180

Solyman, A., Zhenyu, W., Qian, T., Elhag, A. A. M., Toseef, M., & Aleibeid, Z. (2021). Synthetic Data with Neural Machine Translation for Automatic Correction in Arabic Grammar. *Egyptian Informatics Journal*, *22*(3), 303–315. https://doi.org/10.1016/j.eij.2020.12.001

van Dalen, H. P. (2021). How the publish-or-perish principle divides a science: the case of economists. *Scientometrics*, *126*(2), 1675–1694. https://doi.org/10.1007/s11192-020-03786-x

Wu, B., & Zheng, C. (2021). An Analysis of the Effectiveness of Machine Learning Theory in the Evaluation of Education and Teaching. *Wireless Communications and Mobile Computing*, *2021*, 1–10. https://doi.org/10.1155/2021/4456222

Xia, K., Sacco, C., Kirkpatrick, M., Saidy, C., Nguyen, L., Kircaliali, A., & Harik, R. (2021). A Digital Twin to Train Deep Reinforcement Learning Agent for Smart Manufacturing Plants: Environment, Interfaces and Intelligence. *Journal of Manufacturing Systems*, *58*(June), 210–230. https://doi.org/10.1016/j.jmsy.2020.06.012

Xu, X. I. N., Li, D., Sun, M., Yang, S., Yu, S., Manogaran, G., Mastorakis, G., & Mavromoustakis, C. X. (2019). Research on Key Technologies of Smart Campus Teaching Platform Based on 5G Network. *IEEE Access*, *7*, 20664–20675. https://doi.org/10.1109/ACCESS.2019.2894129

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., Liu, J. B., Yuan, J., & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. *Complexity*, *2021*, 1–18. https://doi.org/https://doi.org/10.1155/2021/8812542

Zulharby, P., Rasyid, Y., & Nuruddin. (2019). The Characteristics of Teaching Material Arabic Speaking Skills in Higer Education. *Jurnal Al Bayan: Jurnal Jurusan Pendidikan Bahasa Arab*, *11*(2), 194–213. https://doi.org/https://doi.org/10.24042/albayan.v11i2.5175

Zurqoni, Retnawati, H., Rahmatullah, S., Djidu, H., & Apino, E. (2020). Has arabic language learning been successfully implemented? *International Journal of Instruction*, *13*(4), 715–730. https://doi.org/10.29333/iji.2020.13444a