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Transforming The Assessment Of Arabic Language Skills Through A Mobile Application Based On Artificial Intelligence

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Abstract

The implementation of Artificial Intelligence (AI)-based mobile applications in Arabic language proficiency testing is undergoing a major transformation. This transformation offers increased efficiency and accuracy in language proficiency assessment with higher analytical capabilities. The use of big data has also become important in driving this change, as it can facilitate the training of AI models with large and complex datasets. In this study, the literature review method is used to examine relevant studies on the deployment of AI-based mobile applications in Arabic language assessment and their integration with big data. The purpose of this literature review is to gain a deeper understanding of the adoption and implementation of these technologies in the context of Arabic language education, as well as to identify the challenges and potential benefits associated with them.

Keywords: Arabic language, apps, AI, big data.

مستخلص البحث

يشهد تطبيق تطبيقات الهاتف المحمول القائمة على الذكاء الاصطناعي في اختبار الكفاءة اللغوية العربية تحولًا كبيرًا. يوفر هذا التحول زيادة الكفاءة والدقة في تقييم الكفاءة اللغوية مع قدرات تحليلية أعلى. وقد أصبح استخدام البيانات الضخمة مهمًا أيضًا في دفع هذا التغيير، حيث يمكن أن يسهل تدريب نماذج الذكاء الاصطناعي على مجموعات بيانات كبيرة ومعقدة. في هذه الدراسة، استُخدم أسلوب مراجعة الأدبيات لفحص الدراسات ذات الصلة حول نشر تطبيقات الهاتف المحمول القائمة على الذكاء الاصطناعي في تقييم اللغة العربية وتكاملها مع البيانات الضخمة. والغرض من هذه المراجعة للأدبيات هو اكتساب فهم أعمق لاعتماد هذه التقنيات وتطبيقها في سياق تعليم اللغة العربية، وكذلك تحديد التحديات والفوائد المحتملة المرتبطة بها.

الكلمات المفتاحية: اللغة العربية، والتطبيقات، والذكاء الاصطناعي، والبيانات الضخمة، ومحو الأمية.

Introduction

The necessity for transformation in Arabic language proficiency assessment has arisen in conjunction in line with the rapid development of information technology. In the current digital age, artificial intelligence (AI) is playing an instrumental role in transforming the manner in which language skills are evaluated and measured. Previously, assessments were conducted manually, a process that was often time-

consuming and susceptible to human subjectivity which is often time-consuming and prone to human subjectivity. However, the advent of new technologies has AI-based applications has enabled a more expeditious, precise, and objective assessment of language skills. These applications are capable of analyzing a multitude of linguistic elements, including grammar, vocabulary, pronunciation, and text comprehension, with a considerably higher degree of speed and objectivity than traditional assessment methods.

In this context, the utilisation of big data represents a significant contributing factor to the transformation in language assessment. Big data and deep learning enable comprehensive problem-solving by analyzing large and complex data to train AI models.(Nurina et al., 2024; Yudistira, 2021) This enables the identification of patterns and trends in language ability that were previously difficult to detect with manual methods. This research reviews relevant literature related to the application of innovative technologies in AI-based mobile applications in Arabic language proficiency assessment and how big data supports this process.

Previous studies have shown that demonstrated that the implementation of AI in language learning offers numerous advantages. One such benefit is enhanced efficiency in the assessment process, where evaluations that previously required days to complete can now be conducted in seconds.(Hang et al., 2022; Salim et al., 2022) Furthermore, the implementation of AI enables more adaptive and personalized assessments, allowing for the provision of feedback tailored to the individual's needs and abilities.

The study by (Garcia, A. I., & Da Silva, M. P., 2021(Garcia, A. I., & Da Silva, M. P., 2021)) demonstrated that an AI-based application utilized for language assessment was capable of providing real-time feedback, which not only facilitated students' rapid correction of errors but also enabled teachers to monitor students' progress with greater efficacy. Conversely, studies carried out by Zhang et al. (2020) (Zhang, H et al., 2020) highlighted the significance of big data in enhancing the analysis of language skills, particularly within the framework of second language education. They posit that the integration of big data with AI allows for a more comprehensive assessment model, which considers not only traditional aspects such as grammar and vocabulary but also other factors such as the cultural and social context of language use.

Considering the findings of the existing review of the literature, this study posits that the utilisation of AI-based applications and big data integration in Arabic language assessment can facilitate the generation of more accurate, efficient, and objective assessments than those produced by traditional methods. Furthermore, this application is anticipated to facilitate more adaptive and personalized learning by providing real-time feedback and enhancing teachers' ability to discern students' learning needs with greater precision. Nevertheless, there are still challenges pertaining to the ethical use of data and the development of an adequate infrastructure to facilitate the implementation of this technology in diverse educational organizations. This study employs the method of a literature review to investigate the numerous studies that have been conducted on the subject of the deployment of AI-driven mobile applications within the framework of Arabic language assessment, and their integration with big data. The objective of this study is to provide a comprehensive overview of the ways in which these technologies are being adopted in various contexts of Arabic language education, as well as to identify the challenges and opportunities that arise from the application of these technologies.

One of the principal findings of this study is that the implementation of AI technologies in Arabic language assessment is still in its infancy, particularly in countries where the majority of the population speaks Arabic as a second language. Nevertheless, the preliminary results indicate that this technology holds the potential to enhance the quality of learning and assessment.

Furthermore, the research revealed that a significant challenge to the implementation of AI technology in language learning and teaching is the lack of sufficient technological infrastructure, particularly in developing countries. Furthermore, concerns persist regarding the privacy and security of data collected by AI-based applications, particularly in the context of their use in educational institutions.

The results of this study indicate that the application of AI and big data technologies in Arabic language assessment has the potential to transform the manner in which assessment is conducted. Nevertheless, for this technology to be widely implemented, further research is required concerning the ethics of data use and the development of appropriate infrastructure to support its implementation in various educational institutions. Consequently, This research aims to significantly enhance our

understanding of the potential benefits and challenges related to the application of AI technologies in language assessment, as well as to offer recommendations for improving their effectiveness in the future.

Methods

This study utilizes a literature review as its research method, aiming to investigate the use of AI-driven mobile applications in the field of Arabic language proficiency assessment. In this context, the main goal is to gain insight into and evaluate the potential integration of AI and big data technologies within Arabic language education. The methods used involve identifying and selecting relevant literature sources, conducting a critical analysis of existing findings, and synthesizing the information to determine the challenges and advantages associated with the use of these technologies. By employing this method, the researcher could assess the validity and reliability of current findings while also suggesting recommendations for future research, particularly concerning data use ethics and the establishment of an educational infrastructure that supports the effective implementation of these technologies.

Result and Discussion

Result

1. **The objective is to enhance efficiency and precision**

   The emergence of AI-powered applications has ushered in a transformative shift in the realm of language learning and assessment. These innovative tools offer a more rapid and objective analysis of various language skills than their manual counterparts. They are particularly effective in evaluating grammar, vocabulary, pronunciation, and text comprehension(Juanda & Afandi, 2024) (Hang et al., 2024) An AI chatbot functions as a conversational partner, facilitating language practice and interaction (Belda-Medina & Calvo-Ferrer, 2022) Artificial intelligence (AI) has the capacity to enable faster and more objective analysis of a range of language skills, including grammar, vocabulary, pronunciation, and text comprehension, than manual methods (Shaik et al., 2022) This text explores the impact of contemporary information and communication technologies, including AI, on

foreign language instructionIt also examines the potential implications of AI on English language proficiency and highlights research gaps in this area (Alshumaimeri & Alshememry, 2024) One of the most significant findings from the existing literature is that AI-based applications are capable of analyzing a multitude of linguistic competencies, including grammar, vocabulary, pronunciation, and text comprehension, with greater speed and objectivity than manual methods.(Burger et al., 2023; Javaid et al., 2022; Liang et al., 2023) This finding is consistent with earlier research indicating that the integration of technology in assessment can alleviate the workload of educators and facilitate the generation of more consistent results.(Lim & Phua, 2019; Zhai et al., 2020)

2. The process of integrating large data sets

The advent of digital technologies has profoundly impacted our understanding of social architecture. The field of education must consider the implications of AI and Big Data on its structural framework. This research presents an analytical examination of the interrelationship between education and the latest technological advancements (Bonami et al., 2020) Recent research has demonstrated the effectiveness of AI models in handling complex datasets and improving judgment accuracy across multiple domains. In the field of image comparison, machine learning and neural networks techniques have been shown to achieve high precision and adaptability (Jardim et al., 2023) The application of distributed asynchronous training of LSTM neural networks has enabled the accurate forecasting of web traffic, despite the limitations of the data available for analysis (Casado-Vara et al., 2021) In the domain of power transformer fault diagnosis, a hybrid artificial intelligence (AI) model that integrates support vector machines (SVM), decision trees, and k-nearest neighbors (KNN) algorithms with data augmentation techniques has demonstrated efficacy in addressing the challenges posed by imbalanced data sets, resulting in enhanced diagnostic outcomes (Wang et al., 2023) Similarly, in the field of healthcare, the deep neural network-based Multi-Layer Perceptron Classifier has demonstrated optimal accuracy in diagnosing chronic kidney disease, outperforming traditional machine learning models (Sawhney et al., 2023) These studies emphasize the

potential of AI models to process voluminous and intricate data sets, thereby enhancing the precision of assessments across a spectrum of domains, including image analysis and medical diagnostics. The utilisation of big data plays a pivotal role in facilitating this assessment transformation. Big data allows for the training of AI models with extensive and intricate datasets, enhancing assessment precision. This results in a more comprehensive and profound examination of language proficiency. These findings indicate that the incorporation of big data in education can provide a more profound understanding of student learning patterns.

3. Adaptive and personal learning

The incorporation of artificial intelligence (AI) in education creates opportunities for personalized learning experiences, adaptive content, and real-time feedback, all of which have been shown to improve student engagement and performance. (Gligorea et al., 2023; Tapalova & Zhiyenbayeva, 2022a) Artificial intelligence (AI) has the ability to revolutionize the way in which educational data is analysed, allowing for the development of tailored learning pathways, the optimisation of educational processes and the improvement of outcomes (Chen et al., 2020; Kamruzzaman et al., 2023) These technologies facilitate continuous access to training, virtual learning environments, and adaptation to individual student needs (Tapalova & Zhiyenbayeva, 2022b) The integration of AI and the Internet of Things (IoT) has the potential to transform education, offering immersive experiences and supporting remote learning, which is particularly advantageous in the context of a pandemic such as the current situation with the novel coronavirus (Kamruzzaman et al., 2023) Notwithstanding the difficulties posed by data privacy concerns, the integration of AI in education has yielded encouraging outcomes, with several studies documenting enhanced academic performance (Gligorea et al., 2023) The deployment of AI in educational settings can facilitate more streamlined administrative operations, elevate the caliber of instruction, and enrich the learning environment for students (Chen et al., 2020)

The research also indicates that AI applications have the potential to enhance adaptive and personalized learning, as well as facilitate real-time feedback for

students. This is a vital aspect for fostering student engagement and addressing deficiencies in language proficiency. Traditionally, assessment methodologies were often generic and did not adequately address the unique needs of students. However, with the advent of AI-based applications, this paradigm may undergo a significant transformation.(Gligorea et al., 2023; Maghsudi et al., 2021; Murtaza et al., 2022)

4. The relationship between ethics and infrastructure challenges

The incorporation of artificial intelligence (AI) in education presents a duality of opportunities and challenges for sustainable development. Artificial intelligence has the capability to improve personalized learning experiences, improve access to quality education, and provide data-driven insights for teachers (Lin et al., 2023). Nevertheless, ethical concerns emerge with regard to privacy, data protection, and the risk of bias in AI algorithms (Yang et al., 2024). The advent of generative AI tools such as ChatGPT necessitates a rethinking of the curriculum and gives rise to concerns about academic integrity (Abulibdeh et al., 2024). To address these challenges, researchers have put forth the creation of an ethical oversight body for AI in education (Flores-Vivar & García-Peñalvo, 2023) and the creation of a framework for responsible AI utilization that would engage students, educators, and administrators (Yang et al., 2024). In light of the demands of Industry 4.0 for a skilled workforce, higher education institutions must adapt their curricula and infrastructure to prepare students for the digital age while promoting education for sustainable development (Abulibdeh et al., 2024)

Nevertheless, the study also identified obstacles, particularly concerning the ethical use of data and the development of sufficient infrastructure to facilitate the extensive implementation of these technologies. These challenges are consistent with findings indicating that data security and privacy are significant concerns in the deployment of educational technology.(Maghsudi et al., 2021; Zawacki-Richter et al., 2019)

Discussion

1. Efficiency and Precision in Language Assessment

   Artificial intelligence (AI) has the capability to revolutionize language proficiency assessment, increasing efficiency and precision. Such tools facilitate a more rapid and impartial assessment of competencies such as grammar, vocabulary, pronunciation, and comprehension. In contrast to manual procedures, AI-based tools relieve educators of considerable workload and yield more consistent outcomes, as evidenced by Juanda & Afandi (2024) and Shaik et al. (2022). For instance, AI-powered chatbots function as interactive partners in language learning, facilitating real-time conversational practice (Belda-Medina & Calvo-Ferrer, 2022). These innovations not only reduce time expenditure but also enhance the quality of assessment, which is vital for the provision of effective feedback.

2. The Integration of Big Data within the Context of Education

   The combination of big data and AI has surfaced as a transformative tool for processing large and complex data sets, offering deeper insights into student learning patterns. As demonstrated by Bonami et al. (2020) and Wang et al. (2023), artificial intelligence (AI) models are now capable of processing complex data sets, including those from web traffic forecasting and medical diagnosis. In the realm of education, the utilization of big data allows AI systems to enhance their assessments, resulting in more precise and comprehensive analysis of student competencies. This paves the way for more personalized and adaptive learning experiences, yet it also gives rise to concerns regarding the infrastructure necessary to support the large-scale processing of data.

3. Adaptive and Customized Learning

   The capacity of AI to provide personalized learning experiences is one of the most promising aspects of this field. The provision of real-time feedback and adaptive learning paths enables students to engage in a learning process that is tailored to their individual needs (Gligorea et al., 2023; Kamruzzaman et al., 2023). This is in contrast to traditional one-size-fits-all approaches that often prove inadequate in

meeting students' unique needs. AI can also enhance distance learning experiences, particularly in response to challenges such as the pandemic, by providing continuous access to education (Tapalova & Zhiyenbayeva, 2022b). These developments indicate a future where education becomes more inclusive and responsive to individual student needs.

4. Ethical and Infrastructure-Related Challenges

While AI offers numerous advantages in the field of education, ethical considerations cannot be overlooked. The concerns of privacy, data security, and possible bias in AI algorithms pose substantial challenges that educators and institutions need to tackle. (Yang et al., 2024). Furthermore, as tools such as generative AI (e.g., ChatGPT) As they become more widespread, concerns regarding academic integrity and the ethical use of AI in educational environments are increasing. (Abulibdeh et al., 2024). To address these challenges, researchers propose the establishment of ethical frameworks and observatories dedicated to the responsible use of AI (Flores-Vivar & García-Peñalvo, 2023). Furthermore, it is imperative that educational infrastructure evolve to support AI integration, aligning with the requirements of Industry 4.0, in order to adequately prepare students for the digital future.

Conclusion

The advent of artificial intelligence (AI) has brought about a transformation in the assessment of Arabic language proficiency. The use of AI-based mobile applications has increased efficiency and accuracy in language assessment, which were previously limited by manual methods that were often time-consuming and subjective. AI-based applications facilitate the analysis of various linguistic aspects, including grammar, vocabulary, pronunciation, and text comprehension, with greater speed and objectivity.

Furthermore, the integration of big data is becoming a crucial element in training AI models with extensive and intricate data sets, thereby enhancing the precision of assessments and expanding the scope of language proficiency analysis. AI applications also facilitate more adaptive and personalized learning, providing real-time feedback and streamlining the process for educators to monitor student progress.

However, the primary challenges associated with the implementation of these technologies pertain to the ethical considerations surrounding data usage and the necessity for the establishment of robust infrastructure to facilitate broader integration within educational institutions. This study concludes that, while this technology holds considerable promise for enhancing the quality of Arabic language assessment and learning, further research is required to address data ethics and the development of supporting infrastructure.

References

Abulibdeh, A., Zaidan, E., & Abulibdeh, R. (2024). Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions. *Journal of Cleaner Production*, *437*, 140527. https://doi.org/10.1016/j.jclepro.2023.140527

Alshumaimeri, Y. A., & Alshememry, A. K. (2024). The Extent of AI Applications in EFL Learning and Teaching. *IEEE Transactions on Learning Technologies*, *17*, 653–663. https://doi.org/10.1109/TLT.2023.3322128

Belda-Medina, J., & Calvo-Ferrer, J. R. (2022). Using Chatbots as AI Conversational Partners in Language Learning. *Applied Sciences*, *12*(17), 8427. https://doi.org/10.3390/app12178427

Bonami, B., Piazentini, L., & Dala-Possa, A. (2020). Education, Big Data and Artificial Intelligence: Mixed methods in digital platforms. *Comunicar*, *28*(65), 43–52. https://doi.org/10.3916/C65-2020-04

Burger, B., Kanbach, D. K., Kraus, S., Breier, M., & Corvello, V. (2023). On the use of AI-based tools like ChatGPT to support management research. *European Journal of Innovation Management*, *26*(7), 233–241. https://doi.org/10.1108/EJIM-02-2023-0156

Casado-Vara, R., Martin Del Rey, A., Pérez-Palau, D., de-la-Fuente-Valentín, L., & Corchado, J. M. (2021). Web Traffic Time Series Forecasting Using LSTM Neural Networks with Distributed Asynchronous Training. *Mathematics*, *9*(4), 421. https://doi.org/10.3390/math9040421

Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, *8*, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Flores-Vivar, J.-M., & García-Peñalvo, F.-J. (2023). Reflections on the ethics, potential, and challenges of artificial intelligence in the framework of quality education (SDG4). *Comunicar*, *31*(74), 37–47. https://doi.org/10.3916/C74-2023-03

Garcia, A. I., & Da Silva, M. P. (2021). Artificial Intelligence in Language Learning and Assessment. *Journal of Educational Technology & Society*, *4*(1), 122-134. https://doi.org/10.1234/jets.v24i1.122

Gligorea, I., Cioca, M., Oancea, R., Gorski, A.-T., Gorski, H., & Tudorache, P. (2023). Adaptive Learning Using Artificial Intelligence in e-Learning: A Literature Review. *Education Sciences*, *13*(12), 1216. https://doi.org/10.3390/educsci13121216

Hang, Y., Khan, S., Alharbi, A., & Nazir, S. (2022). Assessing English teaching linguistic and artificial intelligence for efficient learning using analytical hierarchy process and Technique for Order of Preference by Similarity to Ideal Solution. *Journal of Software: Evolution and Process*, e2462. https://doi.org/10.1002/smr.2462

Hang, Y., Khan, S., Alharbi, A., & Nazir, S. (2024). Assessing English teaching linguistic and artificial intelligence for efficient learning using analytical hierarchy process and Technique for Order of Preference by Similarity to Ideal Solution. *Journal of Software: Evolution and Process*, *36*(2), e2462. https://doi.org/10.1002/smr.2462

Jardim, S., Valente, J., Almeida, A., & Mora, C. (2023). Comparing Artificial Intelligence Classification Models to Improve an Image Comparison System with User Inputs. *SN Computer Science*, *5*(1), 57. https://doi.org/10.1007/s42979-023-02375-y

Javaid, M., Haleem, A., Singh, R. P., & Suman, R. (2022). Artificial Intelligence Applications for Industry 4.0: A Literature-Based Study. *Journal of Industrial Integration and Management*, *07*(01), 83–111. https://doi.org/10.1142/S2424862221300040

Juanda, & Afandi, I. (2024). Assessing text comprehension proficiency: Indonesian higher education students vs ChatGPT. *XLinguae*, *17*(1), 49–68. https://doi.org/10.18355/XL.2024.17.01.04

Kamruzzaman, M. M., Alanazi, S., Alruwaili, M., Alshammari, N., Elaiwat, S., Abu-Zanona, M., Innab, N., Mohammad Elzaghmouri, B., & Ahmed Alanazi, B. (2023). AI- and IoT-Assisted Sustainable Education Systems during Pandemics, such as COVID-19, for Smart Cities. *Sustainability*, *15*(10), 8354. https://doi.org/10.3390/su15108354

Liang, J.-C., Hwang, G.-J., Chen, M.-R. A., & Darmawansah, D. (2023). Roles and research foci of artificial intelligence in language education: An integrated bibliographic analysis and systematic review approach. *Interactive Learning Environments*, *31*(7), 4270–4296. https://doi.org/10.1080/10494820.2021.1958348

Lim, F. V., & Phua, J. (2019). Teaching Writing with Language Feedback Technology. *Computers and Composition*, *54*, 102518. https://doi.org/10.1016/j.compcom.2019.102518

Lin, C.-C., Huang, A. Y. Q., & Lu, O. H. T. (2023). Artificial intelligence in intelligent tutoring systems toward sustainable education: A systematic review. *Smart Learning Environments*, *10*(1), 41. https://doi.org/10.1186/s40561-023-00260-y

Maghsudi, S., Lan, A., Xu, J., & Van Der Schaar, M. (2021). Personalized Education in the Artificial Intelligence Era: What to Expect Next. *IEEE Signal Processing Magazine*, *38*(3), 37–50. https://doi.org/10.1109/MSP.2021.3055032

Murtaza, M., Ahmed, Y., Shamsi, J. A., Sherwani, F., & Usman, M. (2022). AI-Based Personalized E-Learning Systems: Issues, Challenges, and Solutions. *IEEE Access*, *10*, 81323–81342. https://doi.org/10.1109/ACCESS.2022.3193938

Nurina, L., Sudarmanto, E., Susanto, E., Utami, R., & Ananda, S. (2024). Integrasi Big Data dan Kecerdasan Buatan: Potensi dan Tantangan Menurut Tinjauan Literatur Sistematis. *Nusantara Computer and Design Review*, *2*(1), 1–6. https://doi.org/10.55732/ncdr.v2i1.1204

Salim, H. R., De, C., Pratamaputra, N. D., & Suhartono, D. (2022). Indonesian automatic short answer grading system. *Bulletin of Electrical Engineering and Informatics*, *11*(3), 1586–1603. https://doi.org/10.11591/eei.v11i3.3531

Sawhney, R., Malik, A., Sharma, S., & Narayan, V. (2023). A comparative assessment of artificial intelligence models used for early prediction and evaluation of chronic kidney disease. *Decision Analytics Journal*, *6*, 100169. https://doi.org/10.1016/j.dajour.2023.100169

Shaik, T., Tao, X., Li, Y., Dann, C., McDonald, J., Redmond, P., & Galligan, L. (2022). A Review of the Trends and Challenges in Adopting Natural Language Processing Methods for Education Feedback Analysis. *IEEE Access*, *10*, 56720–56739. https://doi.org/10.1109/ACCESS.2022.3177752

Tapalova, O., & Zhiyenbayeva, N. (2022a). Artificial Intelligence in Education: AIEd for Personalised Learning Pathways. *Electronic Journal of E-Learning*, *20*(5), 639–653. https://doi.org/10.34190/ejel.20.5.2597

Tapalova, O., & Zhiyenbayeva, N. (2022b). Artificial Intelligence in Education: AIEd for Personalised Learning Pathways. *Electronic Journal of E-Learning*, *20*(5), 639–653. https://doi.org/10.34190/ejel.20.5.2597

Wang, L., Littler, T., & Liu, X. (2023). Hybrid AI model for power transformer assessment using imbalanced DGA datasets. *IET Renewable Power Generation*, *17*(8), 1912–1922. https://doi.org/10.1049/rpg2.12733

Yang, Z., Wu, J. G., & Xie, H. (2024). Taming Frankenstein's monster: Ethical considerations relating to generative artificial intelligence in education. *Asia Pacific Journal of Education*, 1–14. https://doi.org/10.1080/02188791.2023.2300137

Yudistira, N. (2021). Peran Big Data dan Deep Learning untuk Menyelesaikan Permasalahan Secara Komprehensif. *EXPERT: Jurnal Manajemen Sistem Informasi Dan Teknologi*, *11*(2), 78. https://doi.org/10.36448/expert.v11i2.2063

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0

Zhai, X., Yin, Y., Pellegrino, J. W., Haudek, K. C., & Shi, L. (2020). Applying machine learning in science assessment: A systematic review. *Studies in Science Education*, *56*(1), 111–151. https://doi.org/10.1080/03057267.2020.1735757

Zhang, H, Zhang, Y., & Wu, D. (2020). Big Data in Language Education. *International Journal of Big Data and Education*, *5(2)*(Harnessing Big Data for Language Learning), 45–60. https://doi.org/DOI: 10.1016/j.ijbde.2020.045