

IT and Management Strategies for Language Education: Lessons from the Digitalization of Education Activities

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Abstract

The education 4.0 plan had initiated major changes to the education sector's workflow and teaching method. In Indonesia, this sudden transformation is perceived as both an opportunity and a drawback, especially in language learning. This study investigates how technology can be integrated in language education, with the purpose of designing a strategy that addresses pedagogical problems, enhances the implementation of technology, and increases learning effectiveness among students. The methods used in this research are Mixed-method, Comparative analysis, and Framework development. The result shows

that while the shift to online learning presented challenges for both teachers and students, such as technological proficiency and maintaining engagement, it also opened up opportunities to utilize innovative technologies like Automatic Speech Recognition (ASR) and game-based learning to enhance language acquisition. In conclusion, adoption of Information Technology (IT) in the language education sector has its own challenges and opportunity, comprehensive understanding of how IT influences language education during and after pandemic to better guide technological innovation to the betterment of the language education sector.

Keywords: Information technology; language education; literature review

Introduction

The education 4.0 has introduced Information Technology to the education sector. In Indonesia, this was especially challenging for language education, which usually depends on face-to-face interaction and immersive experiences. However, the crisis also created new opportunities to use technology to improve language learning and solve logistical problems (Herawati et al., 2022; Stockwell & Wang, 2023). Therefore, various alternatives to in-person learning were introduced, such as Online Learning Platforms (Adedoyin & Wang, 2023), Mobile Learning (Naciri et al., 2020), Asynchronous Learning (Persada et al., 2022), Blended Learning (Megahed & Hassen, 2022), TV and radio broadcasts (Geni et al., 2021; Prahmana, 2021), new assessment methods (George, 2020), Parental Involvement (Lawrence & Fakuade, 2021), and Flexible Policies (Whalley et al., 2021). Among these alternatives, Online Learning Platforms and Mobile Learning stood out because they are easy to access and effective, thus speeding up the shift toward Education 4.0. Education 4.0 itself focuses on giving students a wide range of skills, such as technical, cognitive, and social abilities, to meet the demands of Industry 4.0 and global challenges. One of the important goals of Education 4.0 is to raise awareness about issues like climate change and its causes. Information technology plays a key role in achieving Education 4.0, which uses advanced technologies to enhance the learning experience.

Research shows that Information Technology and Management can greatly improve language education. Ortikov (2024) pointed out that technology-based learning can help students learn languages more effectively. Bin-Hady et al. (2020) found that ICT (Information and Communication Technology) learning offers more chances for students to use language learning strategies than traditional methods, stressing the importance of using technology to improve both language skills. The COVID-19 pandemic, according to Rapanta et al. (2021), sped up the move to digital learning, pushing schools to adopt technology and integrate it into teaching for a more flexible and engaging experience. Hernandez-de-Menendez et al. (2020) suggested that technology should support teaching methods, not just replace them. Similarly, Zhang & Zou (2022) found that using advanced technology in language teaching has had a very positive effect on learning. There are also various other researches that discuss IT in the language education sector, Table 1 shows the most cited articles that discusses the implementation of IT in language education, and Figure 1-4 shows the research trends regarding the use of IT in the sector. The keywords that are used in the literature review are “Language”, “Education”, “Technology”, and “Indonesia”.

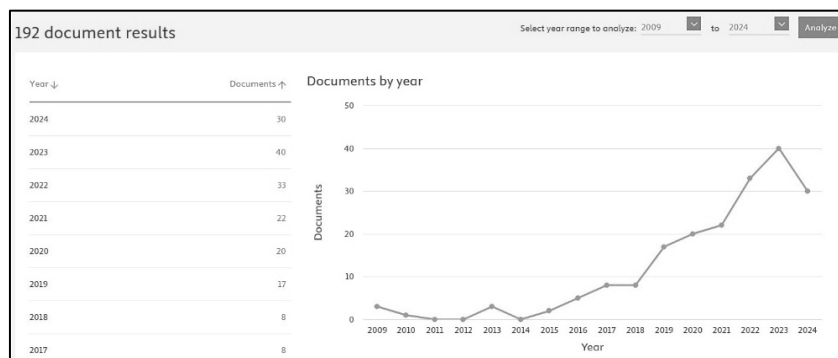


Figure 1. Research trend for the use of IT in Education Sector.

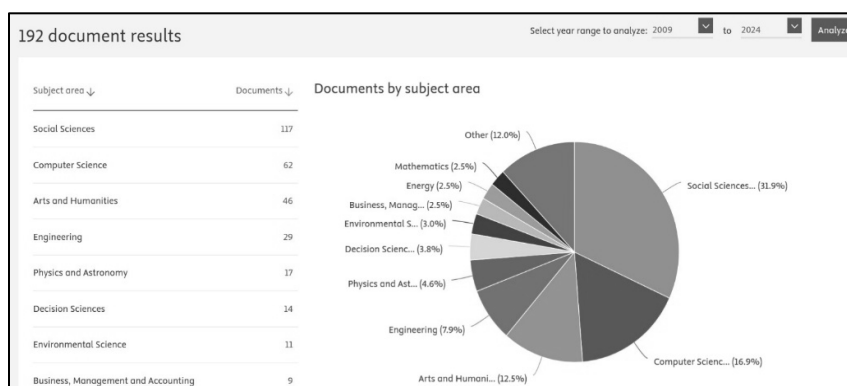


Figure 2. Distribution of research by subject area

Table 1. Top cited Scopus article for the use of IT in education sector.

No.	Title	Cited by
1	Impact of the covid-19 pandemic on online home learning: an explorative study of primary schools in Indonesia (Putri, et al., 2020)	172
2	Secondary school language teachers' online learning engagement during the covid-19 pandemic in Indonesia (Lie, et al., 2020)	97
3	Globalization, English language policy, and teacher agency: focus on asia (Hamid & Nguyen 2016)	69
4	Students' attitudes towards STEM education: Voices from indonesian junior high schools (Suprpto, 2016)	46
5	Online Teaching Benefits and Challenges During Pandemic COVID-19: A Comparative Study of Pakistan and Indonesia (Thaheem, et al., 2022)	27
6	Investigating English Speaking Problems: Implications for Speaking Curriculum Development in Indonesia (Wahyuningsih & Afandi, 2020)	23
7	'Look, I Can Speak Correctly': Learning Vocabulary and Pronunciation Through Websites Equipped with Automatic Speech Recognition Technology (Bashori, et al., 2024)	19
8	University Students' Perceptions Through E-Learning Implementation During Covid-19 Pandemic: Positive or Negative Features Dominate? (Mulyani, et al., 2021)	19
9	Integrating Task and Game-Based Learning into an Online TOEFL Preparatory Course During the Covid-19 Outbreak at Two Indonesian Higher Education Institutions (Pratiwi & Waluyo 2022)	18
10	Artificial Intelligence (AI) Chatbot as Language Learning Medium: An inquiry	113

	(Haristiani, 2019)	
11	Combining chatbot and social media: Enhancing personal learning environment (PLE) in language learning (Haristiani & Rifa'i 2020)	37
12	Gengobot: A chatbot-based grammar application on mobile instant messaging as language learning medium (Haristiani, et al., 2019)	31
13	Android application for enhancing Japanese JLPT N5 kanji ability (Haristiani & Firmansyah, 2016)	27
14	Chatbot-based application development and implementation as an autonomous language learning medium (Haristiani & Rifai 2021)	24
15	How technology can change educational research? definition, factors for improving quality of education and computational bibliometric analysis (Al Husaeni, et al, 2024)	32

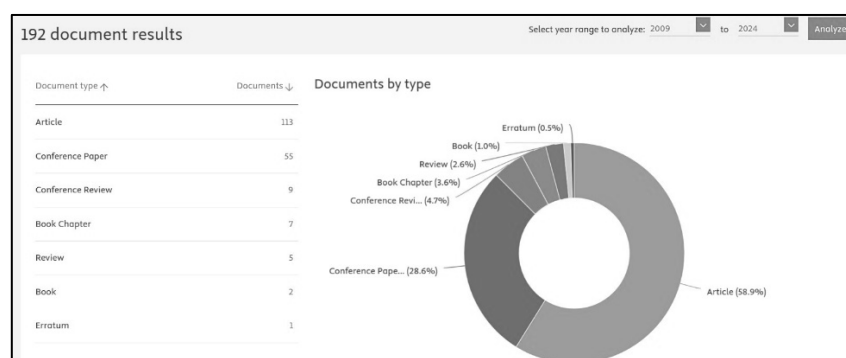


Figure 3. Distribution of research documents by type

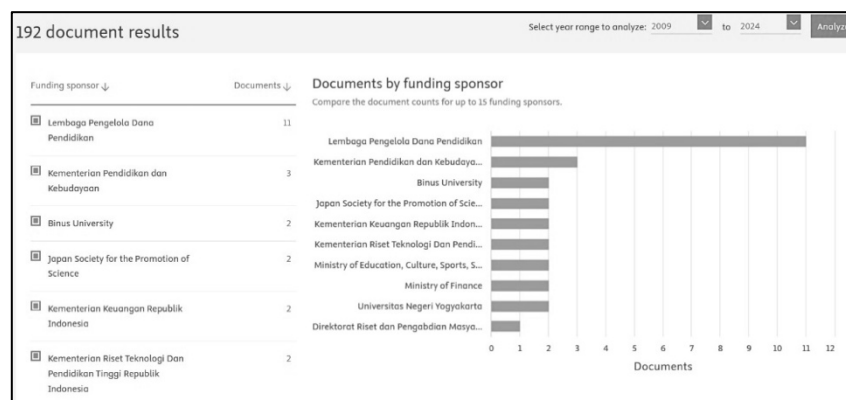


Figure 4. Distribution of research documents by funding sponsor

Previous studies have explored various strategies and management methods for incorporating information technology into language education. The main focus of these studies has been on improving teaching and learning processes, enhancing language learning outcomes, and fostering intercultural communication. Drawing on the findings and discussions from earlier research, this study seeks to offer further practical insights for advancing language education in Indonesia by utilizing information technology and informed management practices.

Research method

This qualitative research used descriptive analysis method to explain the various benefits and detriments from the acceleration of education digitalization in Indonesia, as well as comparative analysis between findings from previous researches to identify common and unique challenges regarding IT implementation. Lastly, framework development is used to develop data in order to propose an operable framework for IT and management strategies in Indonesian language education. The data collection primarily used literature review and observation to gather insights and findings from previous research as well as real-life examples.

The number of published articles that is related for IT and management for language education is 1010 manuscripts. However, only 15,1% (151 papers) from Scopus data base is strongly relevant to the IT and management strategies for language education. The most common key words for this bibliometric analysis are “IT”, “management strategies”, and “language education”.

To ensure the credibility of the bibliometric analysis, the search is done by multiple members of researchers. The use of multiple members of researchers ensures the triangulation of the study and the credibility of the data in this research article.

Results and discussion

The finding of this research provides valuable insights into the synergy between IT and management strategies in the language education sector. Reports regarding education have been well-documented (Tables 2, 3, and 4).

Table 2. Previous studies relating to education

No	Title	Cited by
1	Assessment of Student Awareness and Application of Eco-Friendly Curriculum and Technologies in Indonesian Higher Education for Supporting Sustainable Development Goals (SDGs): A Case Study on Environmental Challenges (Djirong, et al., 2024)	1
2	Prototype of Greenhouse Effect for Improving Problem-Solving Skills in Science, Technology, Engineering, and Mathematics (STEM)-Education for Sustainable Development (ESD): Literature Review, Bibliometric, and Experiment (Solihah, et al., 2024)	25
3	A systematic Literature Review of Internet of Things for Higher Education: Architecture and Implementation (Soegoto, et al., 2022)	13
4	The k-means algorithm for generating sets of items in educational assessment (Riza, et al., 2021)	17
5	An instructional design for online learning in vocational education according to a self-regulated learning framework for problem solving during the covid-19 crisis (Sangsawang, 2020)	161
6	Trends in expert system development: A practicum content analysis in vocational education for over grow pandemic learning problems (Ana, 2020)	108
7	How technology can change educational research? definition, factors for improving quality of education and computational bibliometric analysis (Al Husaeni, et al., 2024)	41
8	Technology-supported project-based learning: Trends, review and future research in science, technology and engineering education (Wahyudi, et al., 2024)	3
9	Counseling guidance in science education: Definition, literature review, and bibliometric analysis (Solehuddin, et al., 2023)	51
10	Computational bibliometric analysis of English research in science education for	20

	students with special needs using vosviewer (Sukyadi, et al., 2023)	
11	A bibliometric analysis: Research trend of critical thinking in science education (Misbah, et al., 2022)	37
12	Usage of internet of things (IoT) technology in the higher education sector (Saeed, et al., 2021)	20

Table 3. Previous studies relating to language education

No	Title	Cited by
1	Technology and hybrid multimedia for language learning and cross-cultural communication in higher education (Farida, et al., 2024)	5
2	Empowering language models through advanced prompt engineering: A comprehensive bibliometric review (Fatawi, et al., 2024)	0
3	Technology and hybrid multimedia for language learning and cross-cultural communication in higher education (Farida, et al., 2024)	5
4	Introduction of Indonesian poem (pantun) as a creative effort of elementary school students in improving language skills in the Covid-19 pandemic era (Medani & Sakti, 2022)	20
5	Influence of parental involvement and school environment on pupils' academic performance in the English language (Saadu, 2023)	2
6	Implementation of early intervention with family resourced to improve development of expressive language in children with cerebral palsy (Abidin, et al., 2021)	9
7	A computer-based approach to teaching foreign languages (Shaturaev & Khamitovna, 2023)	10
8	Impact of communicative language test assessments in enhancing learners' capacity (Jamiu, 2023)	2
9	Evaluation of assessment projects in English language education: A bibliometric review (Oya, 2024)	7
10	Efforts to improve the vocabulary of Indonesian language for 1st-grade elementary students with hearing impairment for through the application of mnemonic (Kurniawati, 2022)	0
11	The weaknesses of the curriculum in the teaching of Arabic (a Muslim language) as a foreign language (Jamiu, 2022)	13
12	Linguistics and semantics difficulties in Arabic language among senior secondary schools in Ekiti, Nigeria (Jamiu, 2023)	1
13	ICT tools for teaching the Arabic language (Sanni, 2023)	10
14	Using illustration images to enhance junior high school students' writing skills (Barbe, et al., 2023)	5
15	Students' strategies and self-efficacy in reading comprehension (Meldawati & Hamid, 2023)	5
16	Mobilizing metacognitive strategies through zoom for EFL classrooms: An innovative practice amidst covid 19 (Cardoso, et al., 2023)	8
17	Students' learning styles in blended English learning in an indonesian private school (Nur & Abduh, 2023)	0
18	Verbal phatic expressions in EFL student teachers' classroom interaction (Alek, 2023)	6
19	Language skills in business context: A bibliometric analysis using the Vos viewer application (Suprayogi, et al., 2024)	1
20	Research gap on differentiated learning in the EFL classroom: A conceptual framework (Mahmud, et al., 2024)	4

21	A validation study of a self-assessment questionnaire for middle school students' self-presentation skills (Tong, 2024)	5
22	Research gap on oral corrective feedback in second language acquisition theory - affective filter analysis: A conceptual framework (Ramdani, et al., 2024)	4
23	A systematic review of EFL students' self-efficacy in the learning context (Gundawan & Wulandari, 2024)	0
24	Improving reading comprehension of narrative text by using L-B-A (literature-based approach) at the ninth-grade students of SMP Negeri 1 Nunukan (Yunisah, et al., 2023)	5
25	Increasing students' vocabulary using fairy tales at SMKN 6 Makassar (Suhardi, et al., 2023)	10
26	English teachers' strategies in creating formative test questions in a public high school (Ibrahim, et al., 2023)	8
27	Area assessment of English in the application of edupreneurship in convention and event business management in a public tourism polytechnic (Suparto, et al., 2023)	7
28	How do english teachers prepare diagnostic assessment for students? Insight from teachers' experiences in an Indonesian remote island (Masbara, et al., 2024)	0
29	Fostering self-directed learning through local wisdom project-based learning (Rosmayanti, et al., 2024)	0
30	Storytelling in higher education: Comparing expectancy- value in task-exposed and non-exposed English learners (Wang, 2024)	0
31	The Importance of English language in tourism sector: a study in Socotra Island (Ahmed, et al., 2024)	0
32	Role-play in language learning: A bibliometric analysis and its impact on Thailand secondary education (Kongsaenkham & Chano, 2024)	0

Table 4. Previous studies relating to IT

No	Title	Ref
1	Utilization and quality of information system for administration services based on ICT in Patehan, Kraton, Yogyakarta (Rachmawati, 2019)	51
2	Teaching and learning with technology: Effectiveness of ICT integration in schools (Shah, 2022).	52
3	Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model (Akinoso, 2023)	74
4	Usability and utilization of ICT among educational administrators in secondary students in public school (Bolaji & Jimoh, 2023)	36
5	Usability of ICT for class size remediation and learning among secondary schools (Bolaji & Onikoyi, 2024)	16
6	An investigation into the conditions of ICT application at the teacher education (Bouasangthong, et al., 2024)	10
7	Information communication technology (ICT) on implementation of higher education (Wanjara & Ogembo, 2024)	1
8	Accessibility, usability, and readiness towards ICT tools for monitoring educational practice in secondary schools (Bolaji & Adeoye, 2022)	41
9	Information communication technology (ICT)-based instructional software and its effectiveness in teaching high school geometry (Arciosa, 2022)	19
10	Lecturers' efficacy and readiness towards utilization of ICT for academic research in college of education (Odefunsho, et al., 2023)	11
11	An assessment strategy using visual basic application in PowerPoint: A free interactive quiz application for ICT class. (Ahillon Jr. & Aquino, 2023)	9
12	Competency level in information and communications technology (ICT) of	3

	teachers: Basis for a technological, pedagogical and content knowledge (TPACK) readiness training program (Ibarrientos, 2024)	
13	Improved information literacy of elementary school students about living pharmacies through information and communication media (ICT) (Dwiana, et al., 2022)	14
14	Utilization of ICT resources for teaching among some selected lecturers in colleges of education in Kwara State (Daramola, 2023)	18
15	Information and communication technology (ICT) integration: A veritable technique for quality secondary education (Bolaji & Ajia, 2023)	7
16	ICT tools for teaching the Arabic language (Sanni, 2023)	10
17	Influence of ICT availability, accessibility, and utilization on agriculture students' academic performance in universities (Makinde, et al., 2023)	3
18	Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model. (Akinoso, 2023)	74
19	Web based instruction for immersion class in Alauddin State Islamic University of Makassar (Farida, et al., 2023)	7

The section discusses the Challenges and Benefits, Technological Innovation, Management Strategies, and Student Attitudes of the language education sector and defines the innovations that have improved the traditional teaching methods, management strategies that increases operational efficiency, as well as how students perceive the technological changes. These aspects collectively give a deeper perspective into the various impacts of digitalization on language education.

Challenges and benefits

Secondary school teachers faced several challenges during the shift to virtual learning environments and addressed them through previous researches shown in Table 5. One significant issue was technological proficiency.

Table 5. Previous researches regarding the shift to virtual learning environments

No	Title	Cited by
1	Immersive intelligent tutoring system for remedial learning using virtual learning environment (Rasim, et al., 2021)	13
2	The use of virtual reality as a substitute for the pre-school students' field trip activity during the learning from home period (Firdiarahma, 2021)	6
3	Colleges of education lecturers' attitude towards the use of virtual classrooms for instruction (Ekunola, et al., 2022)	15
4	Students' learning experiences and preference in performing science experiments using hands-on and virtual laboratory (Bugarso, et al., 2021)	18
5	The effectiveness of using a virtual laboratory in distance learning on the measurement materials of the natural sciences of physics for junior high school students (Azizah, et al., 2022)	29
6	Lecturers perceived proficiency in the use of virtual classrooms for instruction in colleges of education (Ekunola, et al., 2022)	5
7	Development and acceptability of virtual laboratory in learning systematics (Sison, et al., 2024)	10
8	Utilization of virtual reality chat as a means of learning communication in the field of education (Rivky, et al., 2022)	13
9	The effectiveness of using a virtual laboratory in distance learning on the	29

measurement materials of the natural sciences of physics for junior high school students (Azizah, et al., 2022)

Many teachers lacked sufficient training to effectively use digital tools and platforms, which made it difficult to conduct engaging lessons. This problem was not unique to one region; in countries such as the UK and Japan, professional development programs were rapidly introduced to help teachers adapt, though the implementation was often rushed. Another challenge was maintaining student engagement. Language learning heavily relies on interaction, but fostering meaningful participation in virtual settings proved difficult. Teachers struggled to sustain student involvement in activities like group discussions and oral presentations. Scandinavian countries experimented with gamified learning approaches to address this issue, achieving only moderate success. Resource availability also posed a considerable obstacle. Access to quality teaching materials designed specifically for online instruction was often limited, particularly in rural or underfunded schools. Similar challenges were observed in India, where government initiatives like DIKSHA offered partial solutions but failed to fully bridge the gap. Finally, assessment and feedback presented significant hurdles. Evaluating students' language proficiency remotely was particularly challenging, especially for speaking and listening skills. Germany tackled this issue by incorporating artificial intelligence (AI)-assisted tools to aid in language skill assessment, offering a glimpse into potential solutions for this complex problem.

University students have encountered various challenges in adapting to the demands of modern education, particularly during the transition to online learning. One significant hurdle has been the digital divide. Many students struggled with unreliable internet connections or inadequate devices, limiting their ability to fully participate in virtual classes. This issue is not unique to one region; similar barriers have been observed globally, including in South Africa and parts of Southeast Asia, highlighting the widespread nature of this challenge. Another critical obstacle has been the difficulty in maintaining self-regulation and motivation. Without the structure of a physical classroom, many students found it challenging to stay focused and manage their learning schedules effectively. Recognizing this issue, institutions in the United States introduced peer-led study groups as an innovative way to foster accountability and engagement among students. The shift to online learning also led to a loss of social interaction, which significantly impacted students' opportunities for collaboration and networking. These interactions are vital not only for academic success but also for personal development. To address this, Singapore implemented virtual co-curricular activities, providing students with platforms to connect and engage despite the physical distance. For language students in particular, the lack of real-time practice with peers or instructors presented a significant barrier to developing key skills, such as speaking and listening. South Korea tackled this issue by employing immersive virtual reality tools designed to replicate classroom interactions, offering students an engaging and effective way to practice language skills in a virtual environment. These challenges and global responses underscore the complexities of modern education and the innovative strategies required to overcome them.

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Equity issues have emerged as a significant challenge in addressing the digital divide worldwide. Wealthier countries such as the United States and Germany were able to mitigate this barrier relatively quickly by investing heavily in digital infrastructure. However, low-income regions like sub-Saharan Africa faced considerable difficulties. For instance, in Kenya, some non-governmental organizations attempted to bridge the gap by providing solar-powered tablets to students. Despite the innovation, these efforts were not scalable and failed to provide a long-term solution to the widespread disparity. Cultural differences also played a crucial role in determining how effectively countries adapted to digital learning. Nations with a strong culture of self-directed learning, such as Finland, transitioned to online education with relative ease. Finnish students, accustomed to managing their own learning processes, found online platforms less intimidating. In contrast, countries like Italy struggled due to their reliance on teacher-led instruction, which proved less adaptable to remote learning environments. The availability of technological solutions further shaped the success of digital education transitions. Countries with advanced educational technology ecosystems leveraged tools such as artificial intelligence, virtual reality, and cloud-based platforms to enhance learning. For example, South Korea utilized VR tools to provide immersive language learning experiences. On the other hand, developing nations often had to rely on basic communication technologies like WhatsApp and SMS. In Bangladesh, TV-based lessons were employed to reach a wider audience, reflecting the limited access to more sophisticated solutions. Community support was another critical factor in navigating the challenges of digital education. Collaborative efforts between governments, educators, and families often determined the effectiveness of the transition. In Japan, parent-teacher associations were instrumental in supporting students and ensuring continuity in education. Similarly, universities in the United States partnered with local businesses to provide students with workspaces equipped with free internet access, addressing connectivity issues. Conversely, some countries experienced fragmented efforts, which hindered their ability to adapt to the new demands of digital learning.

Technological innovation

Many technologies have been developed to support the teaching and learning process. Many reports regarding the use of technology have been well-documented, and several examples include (See Tables 6-16):

Augmented reality (AR)

Table 6. Previous researches in AR

No	Title	Cited By
1	Augmented reality for cultivating computational thinking skills in mathematics completed with literature review, bibliometrics, and experiments for students (Angraini, et al., 2024)	22
2	Development of augmented reality application for exercise to promote health among elderly (Bangkerd & Sangsawang, 2021)	26
3	Application of augmented reality technology with the fuzzy logic method as an online physical education lecture method in the new normal era (Albar, et al., 2021)	28
4	How to create augmented reality (AR) applications using unity and vuforia engine to teach basic algorithm concepts: Step-by-step procedure and bibliometric analysis (Al Husaeni, et al., 2024)	0

Virtual reality (VR)

Table 7. Previous researches in VR

No	Title	Cited By
1	The use of virtual reality as a substitute for the pre-school students' field trip activity during the learning from home period (Firdiarahma, 2021)	6
2	Utilization of virtual reality chat as a means of learning communication in the field of education (Rivky, 2022)	13

Internet of things (IoT)

Table 8. Previous researches in IoT

No	Title	Cited by
1	A systematic review of the IoT in smart university: Model and contribution (Luckyardi, et al., 2022)	21
2	Mesh network based on MQTT broker for smart home and IIoT factory (Anh, 2022)	11
3	Easy-mushroom mobile application using the Internet of Things (IoT) (Thapwiroch, et al., 2021)	28
4	Greening the internet of things: A comprehensive review of sustainable IOT solutions from an educational perspective (Jebur, 2023)	12
5	Water quality monitoring in citarum river (Indonesia) using IoT (internet of thing) (Pantjawati, et al., 2020)	22

Artificial intelligence (AI)

Table 9. Previous researches in AI

No	Title	Cited by
1	Artificial intelligence (AI)-based learning media: Definition, bibliometric, classification, and issues for enhancing creative thinking in education (Solihat, et al., 2024)	10
2	Trends in the use of artificial intelligence (AI) technology in increasing physical activity (Rahayu & Ismail, 2023)	0
3	Bibliometric analysis of research trends in conceptual understanding and sustainability awareness through artificial intelligence (AI) and digital learning media (Fiandini, et al., 2023)	0

- | | | |
|---|--|---|
| 4 | The future of learning: ethical and philosophical implications of artificial intelligence (AI) integration in education (Nurhasanah & Nugraha, 2024) | 0 |
|---|--|---|

Learning management systems (LMS)

Table 10. Previous researches in LMS

No	Title	Cited by
1	Determinants of learning management system (LMS) adoption by university students for distance learning (Soko, et al., 2024)	10
2	The influence of spada learning management system (LMS) on algorithm learning and programming of first grade students at Universitas Pendidikan Indonesia (Al Husaeni & Hadiano, 2022)	15

Gamification

Table 11. Previous researches in gamification

No	Title	Cited by
1	Influence of gamification elements on students' academic performance (Adeoye, 2023)	5
2	Students' attitude towards gamification-based teaching in mathematics in basic schools (Attah, et al., 2024)	3
3	Undergraduate students' awareness to adopt gamification for learning in University of Ilorin, Nigeria (Ekunola, et al., 2022)	4

3D printing and prototyping models in STEM education

Table 12. Previous researches in 3D printing and prototyping models in STEM education

No	Title	Cited by
1	Prototype of greenhouse effect for improving problem-solving skills in science, technology, engineering, and mathematics (STEM)-education for sustainable development (ESD): Literature review, bibliometric, and experiment (Solihah, et al., 2024)	25
2	Improvement of students' literacies skills in the knowledge aspect through science, technology, engineering, and mathematics (STEM)-integrated module (Fitrianti, et al., 2024)	5

Blockchain

Table 13. Previous researches in blockchain

No	Title	Cited by
1	Use of blockchain technology for the exchange and secure transmission of medical images in the cloud: Systematic review with bibliometric analysis (Lizama, et al., 2024)	24

Cloud computing

Table 14. Previous researches in cloud computing

No	Title	Cited by
1	Use of blockchain technology for the exchange and secure transmission of medical	24

images in the cloud: Systematic review with bibliometric analysis (Lizama, et al., 2024)

Robotics

Table 15. Previous researches in robotics

No	Title	Cited by
1	The mobile robot control in obstacle avoidance using fuzzy logic controller (Khairudin, et al. 2020)	46
2	Smart materials and their application in robotic hand systems: A state of the art (Castiblanco, et al., 2021)	37
3	Embedded design and implementation of mobile robot for surveillance applications (Al-Obaidi, et al., 2021)	55
4	Measurement enhancement of ultrasonic sensor using pelican optimization algorithm for robotic application (Khaleel, et al., 2024)	10
5	Construction process of robotic devices to teach aspect of auto mechanic in Nigeria Basic Schools (Babalola & Omolafe, 2022)	16
6	Babalola, E.O., and Omolafe, E.V. (2022). Detail experimental procedure for the construction process of robotic devices to teach aspect of auto mechanic. ASEAN Journal of Science and Engineering Education, 2(2), 169-176.	13

Big data

Table 16. Previous researches in big data

No	Title	Cited by
1	Big data technology in education: Advantages, implementations, and challenges (Bamiah, et al., 2018)	73

One of the technologies is Automatic Speech Recognition (ASR). ASR technology plays a crucial role in enhancing language learning by converting spoken language into text through algorithms and machine learning. One of the key benefits of ASR in language acquisition is its ability to improve pronunciation. ASR systems can provide real-time feedback by comparing a learner's speech to native speaker models, highlighting discrepancies, and guiding learners to self-correct. This feature is commonly used in language learning apps like Duolingo and Rosetta Stone, which help users become more aware of their pronunciation errors and refine their speaking skills.

ASR also supports vocabulary acquisition by engaging learners in conversation and assisting them in recalling words in context. This approach not only exposes learners to new vocabulary but also reinforces memory retention. By practicing speaking through ASR systems, learners can actively use words in sentences, which strengthens their ability to recall and apply them in real-life situations. Additionally, ASR adapts to a learner's skill level, providing personalized challenges that accelerate the learning process. Whether focusing on vocabulary, fluency, or pronunciation, this tailored feedback ensures learners can efficiently address their areas of improvement.

Task-based and game-based learning are also powerful tools in the teaching and learning process (Table 17). These interactive, immersive activities make learning more engaging and enjoyable, motivating learners to practice. Task-based learning, for example, uses realistic and meaningful contexts to encourage the use of language. Learners might engage in tasks such as

solving problems or completing projects in the target language, which helps them internalize vocabulary through practical application. For instance, an online scavenger hunt or a simulation game might require the use of specific vocabulary, reinforcing its context and improving retention.

Table 17. Previous research in task-based and game-based learning

No	Title	Cited by
1	The use of the Natuna game about the natural wealth of the natuna marine on national awareness of the post-millennial generation (Ibrahim, et al., 2024)	2
2	Examining the effects of online games on the academic performance of BPED students of Sultan Kudarat State University, Philippines (Cabrillos, et al., 2023)	15
3	The effect of the team-games-tournament method on improving the learning ability of student with hearing impairment in multiplication concepts (Rusyani, et al., 2021)	15
4	Basic arithmetic learning through math online games for elementary school students during the pandemic (Lathifah & Maryanti, 2021)	23
5	Ways to develop education for obtaining general physical qualities of young wrestlers through action games (Jurayevich, 2023)	36
6	Post-traumatic counselling through group games (Hafina, 2023)	5
7	Designing a notation card game media to improve the ability to read rhythmic music of 7th grade junior high school (Sella, et al., 2024)	0
8	Game-based activity method: A case of grade 5 students (Hanna, et al., 2021)	7
9	Designing English education game application for early childhood (Albion, et al., 2021)	10
10	Application of scrabble game in improving learning of simple sentence structure on the student with hearing impairment (Rusyani, et al., 2022)	9
11	Effect small side games (SSG) on playing skills in handball sports (Ramdhani & Saputra, 2023)	7
12	Rehabilitation program for surgical shoulder joint protrusion among team games players injured (Yaseen, 2023)	6
13	Basic arithmetic learning through math online games for elementary school students during the pandemic (Lathifah & Maryanti, 2021)	23

In game-based learning, pronunciation practice is often integrated into speech-based tasks, which encourage learners to repeatedly practice speaking. Games can incorporate ASR technology to assess and provide feedback on pronunciation, making the process more motivating than traditional methods. The competitive elements of games, where learners strive to "level up" or earn points, further incentivize them to continue practicing. The interactive and fun nature of games also keeps learners engaged, while the repetitive practice in varied contexts helps them retain and recall vocabulary.

Both task-based and game-based learning immerse learners in language-rich environments, providing valuable context for pronunciation practice. For example, a game simulating real-world situation, such as ordering food at a restaurant, can encourage learners to use specific phrases and vocabulary. In these environments, learners receive real-time corrections on their pronunciation, further reinforcing their language skills.

The integration of ASR technology with game-based learning platforms offers a comprehensive approach to language acquisition. By combining ASR's real-time feedback with the interactive elements of language games, learners can practice pronunciation and acquire new vocabulary in a context-rich environment. This approach not only promotes active learning but

also enhances vocabulary retention and pronunciation accuracy through repeated practice and feedback loops.

In conclusion, ASR and task/game-based learning technologies provide dynamic and engaging ways to improve language acquisition, particularly in the areas of vocabulary and pronunciation. ASR offers real-time feedback to refine pronunciation, while task-based and game-based learning environments foster active vocabulary acquisition. When combined, these technologies offer a holistic and motivating learning experience that emphasizes skill development and encourages ongoing practice.

Management strategies

In the context of globalization's influence on English language policy and teacher agency, effective IT management strategies for schools and universities must prioritize the integration of digital learning platforms. These platforms should be designed to support both synchronous and asynchronous learning, enabling global collaboration and resource sharing in English. With features like real-time language translation, interactive multimedia, and cloud-based document sharing, digital platforms can break down language barriers, providing a diverse, global student body with the tools needed to engage with academic content effectively.

To complement these digital tools, schools and universities must invest in the professional development of their teachers. Regular training sessions focused on technology integration in teaching, improving English language proficiency, and understanding global educational trends are essential. Such professional development empowers teachers to adjust to the ever-evolving demands of the classroom, enhancing their sense of agency in shaping learning experiences while ensuring they are prepared to teach in a globalized educational environment.

In addition, language support tools are crucial in a globalized context. Implementing AI-based language assistants, translation software, and online dictionaries can assist both students and teachers in overcoming language challenges. These tools help non-native English speakers navigate academic content more easily, ensuring that language barriers do not hinder their learning. By providing robust language support, institutions can make English more accessible to a wider range of learners, fostering inclusivity and enhancing the learning experience for all.

Global collaborations and virtual exchange programs are another key strategy to adapt to globalization. Schools and universities can facilitate international partnerships that allow students and teachers to connect with peers worldwide. Such initiatives expose both educators and students to various English accents, terminologies, and cultural contexts, enriching their language skills and broadening their perspectives. This exposure not only enhances English proficiency but also fosters a deeper understanding of global issues and diverse viewpoints.

Investment in cloud-based infrastructure is also essential for modernizing IT management. Cloud services enable seamless access to resources, data storage, and communication tools, allowing students and faculty to collaborate from anywhere in the world. This flexibility and scalability are vital in meeting the demands of a globalized education system, ensuring that students and teachers can continue their work regardless of their physical location.

With the increasing reliance on mobile technology, schools and universities must leverage mobile learning solutions to support learning outside the classroom. Mobile platforms offer students and teachers the convenience of accessing educational materials, assignments, and language tools anytime, anywhere. These mobile learning solutions can be designed to support multilingual environments, ensuring that English language learners can use the tools they need to succeed in their academic journeys.

Data-driven decision-making is another crucial element of effective IT management. By using data analytics to monitor student performance and technology use, institutions can make informed decisions about improving teaching methods, IT infrastructure, and language support. This data-driven approach ensures that the strategies implemented are continuously refined and optimized to meet the changing needs of a globalized education system.

Finally, schools and universities must create inclusive IT policies that ensure equitable access to technology for all students and teachers. These policies should focus on affordability and accessibility, addressing the diverse needs of learners, including those with disabilities or from underserved communities. By fostering an inclusive digital learning environment, institutions can ensure that all students have the opportunity to succeed in a globalized world. By implementing these IT management strategies, schools and universities can navigate the challenges posed by globalization, empowering both students and teachers to excel in a connected, English-dominant academic world.

Student attitudes

In addition to technology, student attitude is also important, which is not only for the successful teaching and learning process but also students' future. Many reports regarding this matter have been well-documented (Table 18). Exploring students' attitudes towards IT-driven education through parallels with Science, Technology, Engineering, and Mathematics (STEM) education provides valuable insights into how technology can impact learning in various disciplines, including language education. In STEM fields, students generally have a positive attitude towards technology, often viewing it as an essential tool for solving complex problems and enhancing learning experiences. These students tend to embrace technological tools such as simulations, programming languages, and digital resources. Similarly, in language learning, students are increasingly adopting IT tools like language learning apps, online dictionaries, and interactive platforms. When students have a positive attitude towards these tools, their engagement and motivation in language learning tend to improve. Therefore, language curriculum designers should prioritize integrating technology to create interactive, engaging, and dynamic learning environments. This could involve using multimedia resources such as videos, podcasts, language exchange platforms, and gamification techniques, aligning with students' interest in using technology for learning.

Table 18. Previous research in student attitude

No	Title	Cited by
1	Association of interest, attitude and learning habit in mathematics learning towards enhancing students' achievement (Hashim, et al., 2021)	75
2	Attitude of Sultan Kudarat State University laboratory high school students and teachers on proposed "no homework policy" bill (Lumbu-ani, et al., 2021)	13
3	Students 'attitude towards the utilization of google classroom for learning (Olumorin, et al., 2022)	7
4	Colleges of education lecturers' attitude towards the use of virtual classrooms for instruction (Ekunola, et al., 2022)	15
5	A study on attitude of urban and rural college student teachers towards science (Shah, 2022)	3
6	Command secondary school teachers' attitude towards information and communication technology facilities for instruction (Daramola, 2022)	5
7	Polytechnic student's attitude and their achievement in the use of English and	5

	communication course for learning (Olowoyeye et al., 2022)	
8	Postgraduate students' attitude towards the use of digital library repositories for research in Kwara State (Ogunleye, 2023)	9
9	The attitude of distance learners towards the utilization of learning management system (A case study of National Open University of Nigeria) (Ajijola, 2021)	10
10	Attitudes of high special school students with hearing impairment to online adaptive physical education learning (Rusyani, Permana, and Ragadhita, 2022).	6
11	Attitudes and perceptions towards cultured meat among general population in Pakistan (Ahsan, Uzair, and Ali, 2022).	11
12	A study on attitude of urban and rural college students towards science. (Shah, 2022).	0
13	Perceptions and attitudes of Nigerian students Above 18 years old towards Laboratory-cultured Meat (Owokoniran, 2024)	17
14	Problem-based learning on students' attitude towards science: An action research (Rahmadani, et al., 2024)	5
15	Exploration of students' attitudes towards science: A case study research in junior high schools (Laksmiana, et al., 2024)	0
16	Attitude of hearing-impaired students towards assistive technology utilization in Oyo state adopting the survey method (Soetan, et al., 2021)	14
17	Knowledge, perceptions, and attitudes towards dementia among medical students in Pakistan (Ahsan, et al., 2022)	3
18	College-bound students' attitudes about investments and the stock market (Deshpande & Jadhav, 2023)	0

However, challenges and resistance to IT integration can also arise. In STEM education, while many students embrace technology, some may resist its use, particularly if they face issues like insufficient resources or lack of familiarity with certain technologies. This resistance may also stem from traditional teaching methods that undervalue the role of technology in learning. The same can occur in language education, where students may struggle to adopt IT-driven approaches due to factors such as limited digital literacy, concerns about technology replacing face-to-face interactions, or frustrations with unreliable tools. To address these concerns, language curricula should not only focus on the benefits of technology but also provide clear guidance on how to effectively use IT tools. By addressing potential challenges and misconceptions, educators can ensure that IT complements traditional teaching methods rather than replacing them.

Equitable access to resources is another important consideration. In STEM education, the adoption of IT can be hindered by unequal access to technological resources, such as high-performance computers or reliable internet connections, especially in underfunded or rural areas. This issue is equally relevant to language education, where students in less privileged environments may not have access to the necessary technology for IT-driven learning. To ensure that technology is used effectively in language curricula, designers must consider equitable access and incorporate a range of digital tools that are accessible to all students. This might include providing low-cost or offline alternatives for students who have limited access to digital resources.

The role of teachers in the integration of technology is crucial in both STEM and language education. In STEM, teachers are often seen as facilitators who not only impart knowledge but also guide students in using digital tools and resources effectively. The same is true in language education, where teachers must play an active role in encouraging students to

engage with technology while providing support for overcoming technical challenges. Language curricula should, therefore, prioritize professional development for educators, ensuring they have the skills and knowledge to integrate technology effectively into their teaching. This focus should be on the pedagogical use of IT tools, not just their technical aspects.

Finally, technology can serve as a catalyst for collaborative learning, a feature that is valued in both STEM and language education. In STEM, tools such as coding platforms, online forums, and shared digital workspaces enhance teamwork and problem-solving among students. In language learning, digital tools can similarly facilitate collaboration, enabling students to engage in online discussions, provide peer feedback, and participate in virtual language exchanges. Language curricula should encourage these forms of collaboration, promoting interaction among students from different linguistic and cultural backgrounds. This not only helps improve communication skills but also fosters cultural understanding and language proficiency.

By examining students' attitudes towards IT-driven education and comparing them with attitudes in STEM fields, educators and curriculum designers can craft more effective language learning environments. This involves fostering positive attitudes towards technology, addressing challenges, ensuring equitable access, supporting teachers, and promoting collaborative learning. With these considerations in mind, IT-driven education can significantly enhance language learning experiences and outcomes

Conclusion

In conclusion, integrating IT into language education brings both challenges and advantages. Some of the challenges include teachers' technological skills, student engagement in online environments, access to resources, and issues with assessment and feedback. On the other hand, the benefits include the use of technologies such as Automatic Speech Recognition (ASR) to improve pronunciation and vocabulary, as well as task-based and game-based learning methods that make language learning more interactive. Successful IT integration relies on effective management strategies, which involve using digital platforms for global collaboration, supporting teacher development, offering language tools, creating opportunities for virtual exchange, investing in cloud infrastructure, implementing mobile learning solutions, utilizing data-driven decision-making, and establishing inclusive IT policies. Students generally have a positive attitude towards IT in language education, much like their enthusiasm for STEM subjects. They view technology as a helpful tool for enriching their learning experiences. However, challenges like resistance to IT adoption and unequal access to resources must be addressed. While challenges persist, IT can greatly enhance language education if implemented with careful consideration of teaching methods, management strategies, and student needs, aligning with the goal of creating a comprehensive IT plan for language education.

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