

## Research Article

# Playing with AI to Investigate Human-Computer Interaction Technology and Improving Critical Thinking Skills to Pursue 21<sup>st</sup> Century Age

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As part of the human-computer interaction (HCI) that artificial intelligence has, it has a specific effect on developing critical thinking skills, which is what this study is looking at. The purpose of this study was to determine the impact of AI friend apps on EFoLLe (English foreign language learners) interactions with technology. The primary focus of this paper is on a new artificial intelligence-based immersion teaching method for university-level English. Students' English proficiency and CT are the primary goals of this course. This study employs mixed methods research design using an online survey and classroom observation. Both quantitative and qualitative data collection and analysis techniques helped researchers to understand deeply. Still, little research was used to look at the survey and how people acted while they were learning how to use AI to improve CT skills. The participants in this paper were polled using an online survey. A total of 453 people participated in the survey. According to the outcomes of the study, AI friends to enhance students' critical thinking abilities has a positive impact among the participants. Because AI-based instruction promotes students' trust, self-confidence, open-mindedness, and maturity in English, it can help them improve their critical thinking skills. This is because critical thinking skills are the foundation for 21<sup>st</sup>-century skills, and AI-based instruction helps students learn these skills. This study helped AI-based instruction because it helps nonnative English students become more trusting, self-confident, open-minded, and mature in English. It also helps them learn the CT skills that are the foundation of critical thinking, so they can learn new skills in the 21<sup>st</sup> century.

## 1. Introduction

A new generation of intelligent machines and technological advancements is directly tied to the future of higher education. There are new possibilities and difficulties for teaching and learning in higher education that can radically affect the governance and the internal architecture of higher education institutions, thanks to breakthroughs in artificial intelligence. According to Aristotle, there has been little agreement on the ultimate definition of artificial intelligence, which has been formed by philosophical perspectives (Popenici and Kerr) [1].

This technology, known as artificial intelligence (AI), is gaining in popularity, and educators are taking notice.

Students who learn artificial intelligence (AI) are more equipped to deal with the issues of today's society, technology, and environment. Individuals and nations alike have placed a high value on acquiring a foreign language in the twenty-first century. Amaral and Meurers [2] assert that, historically, language learning has taken place primarily through receptive classroom participation. The widespread adoption of AI technology in language education has led to a more effective practice framework in the classroom that considers each student's unique strengths and weaknesses as a learner. For language teaching and learning, for instance, Lin and Chang, we can use web-based systems, VR systems, and chatbots to create individualized, interactive, and authentic settings (Lin and Chang [3]).

Agarwal and Chakraborty [4] said that AI-based learning systems had been shown by several studies to improve student learning performance and assist teachers in understanding student learning problems, such as several studies conducted by Deeva et al. [5]. Both Benford et al. [6] and Woolf et al. [7] provide evidences for automatic feedback in learning, automated writing evaluation, automated essay grading, and intelligence guidance systems. Now, researchers have more opportunities than ever to analyze massive datasets of instructional behavior from databases covering elements of instruction, learning, emotion, motivation, and social interaction, all with the help of artificial intelligence. Researchers and educators can gain a deeper understanding of the benefits of a personalized learning environment if they draw on data collected from students and groups' experiences, reflections, and analyses. Researchers have pointed out the need for review studies to understand better the ethical and educational approaches involved in implementing Artificial Intelligence in Education in higher education and the almost complete absence of critical reflection on Artificial Intelligence in Education challenges and risks [8, 9].

Review studies are a great starting point for new researchers because they detail the newest trends in the field. Thus, a review study is warranted to aid researchers in this area in comprehending Artificial Intelligence in Education trends and research foci. However, most of the existing review studies have focused on assessing the impact of AI on the acquisition of particular language skills (such as digital support for academic writing or intelligent tutoring systems for K-12 students' reading comprehension) (AI in language education). Not only that, but the vast majority of prior reviews only covered the preceding 20 years (e.g., [10–13]).

Students' evaluation processes at the university and preuniversity levels can benefit from the use of AI technologies, according to Borge [14]. When it comes to measuring students' levels accurately, this might be a challenge for instructors. Assessing the educational processors allows university teachers to identify any faults in the lecture content or instructional material that students are exposed to. Each student's unique abilities and demands may be accommodated by AI because it includes sophisticated programs that recognize common mistakes among students, provides instructors clues as to what they are doing wrong, and provides rapid feedback tailored to each student's specific needs. In addition, AI technologies and algorithms can deal with the high density of classrooms. It may be deduced from the information above that AI concentrates on two issues.

Theoretically, mental processes and actions are described and interpreted, and human behavior is represented in real-world tasks and situations. A more practical concern is the use of intelligent tools and machines to model human behavior. AI has many useful applications in the realm of education, including knowledge representation and storage, as well as a variety of models for student-student and student-machine interaction. Software that translates between English and Arabic using up-to-date dictionaries that give the correct meaning of words when used in context can be a

great tool for students. Reading passage concepts, sentence and paragraph structure, and letter and word recognition can all be provided by these programs. They are able to detect word mappings and connect texts, images, and sounds.

In universities, educational robots are used to teach English, but unfortunately, the integration of RALL (robot-assisted language learner) is still very rarely done. The design of a robot-based educational resource system is very important to do. This study wants to examine how RALL, one of which is an AI friend in EFL, has the functions of teaching conversation, role-playing, and free discussion when using the AI robot friend platform in teaching EFL. The robotics-based TEFL teaching curriculum was developed using the RALL approach to improve 21<sup>st</sup>-century higher-order thinking skills. In the course, the relevant educational robot functions are fully utilized to complete many teaching activities, such as classroom interactions, group discussion, and knowledge carding. University students were surveyed to see if robot-assisted teaching had a positive impact on CT. Student CT and classroom effectiveness are enhanced by using robots in the classroom. Robot-assisted educational research will greatly benefit from this investigation, for which AI technology assistance is critical. Researchers and teachers trying to improve the field of artificial intelligence education will learn a lot from this study's findings about how to teach critical thinking.

## 2. Literature Study

*2.1. Collaborative Mobile Learning Environment.* The pedagogical literature is replaced with evidence that small group educational activities increase collaborative skills and foster learning (Jia et al. [15]; Hamadi et al. [16]). According to Huang et al. [17], Al Hamdani [18] showed that mobile learning environments can be designed by integrating three factors: context, objectives, and experiences established a framework for this purpose. Cooperative mobile learning environment design research is initially examined to help guide the development and analysis of software prototypes. As a result of mobile learning, people can gain access to more educational content at any time and from any location using their mobile phone (smartphone). Individuals benefit from this practicality since it enhances their educational experience.

Collaborative mobile learning is a strategy used by educators to improve student achievement and engagement in the 21<sup>st</sup>-century era. Several pedagogical strategies are compatible with digital learning. When used in a group setting, mobile learning takes on a more participatory quality [19]. According to Vogel et al. [20], interaction and information exchange can explain the value of collaborative learning in both formal and informal contexts. The convenience and portability of mobile devices has encouraged collaborative learning studies in group settings. Collaborative mobile learning is defined by Jain et al. [21] as an activity that enables transparent collaboration by empowering group members' social negotiation space, coordinating between activity states, encouraging mobility of group or team members, perhaps mediating interactivity, and organizing

material that managed and allows students to work together in groups via wireless networks that support face-to-face social communication.

During collaborative mobile learning sessions, participants can share and learn from a variety of media, including video clips, instant messages, photos, music, simulations, and animations, making the experience both educational and enjoyable [22]. Multimedia resources such as video, audio, images, simulations, and animations are the key ideas proposed by Reis et al. [23] to improve the mobile environment. Users in collaborative learning settings can easily and quickly explain their perspectives using artifacts with multimedia input. The literature under this title shows that mobile learning allows students to study whenever and wherever they like. However, education opportunities both in and out of the classroom depend on having some fundamental characteristics that are not always available. Having access to mobile technology, a reliable Internet connection, technology backed by multimedia capabilities and quality pieces of learning content is the bare minimum required to lead to learning in such media. Collaborative means sharing and discussing ideas that creates another option for learning. Knowledge sharing, group discussion, assigned group assignments, and other forms of pervasive knowledge acquisition can all be facilitated by mobile learning in collaborative settings. Individual curiosity about a topic can be piqued, increased, motivated, and maintained through collaborative mobile learning via a portable device or smartphone, especially if the topics covered are very challenging. Online group project members have a way of communicating with each other and sharing details about themselves through this collaboration.

A complex idea can be better understood by students if it is broken down into manageable parts and delivered via a mobile platform (smartphone), where they can be supplemented with audio, video, simulation, and animation. When students actively participate in a collaborative learning environment, the different types of media used in mobile learning content likely have a positive impact on their level of intellectual engagement. Individual participation in group assignments in mobile learning endeavors is driven by the availability and accessibility of social network applications, which in turn triggers the initiation of long-term relationships in disciplinary areas and professional interests among members participating in collaborative settings. However, it should be noted that the instructor's approach, quality of instructional content, specification of group dynamics, and appropriate linkage of multimedia tools to appropriate activities and tasks can all increase the efficacy of collaboration in mobile learning.

If it does not hinder studying, mobile devices can be an asset to students. Several aspects have been considered by researchers to solve the issue of mobile learning's effectiveness in the deployment of mobile learning environments. Park [24]; Bernacki et al. [25]; Rapanta et al. [26]; and Breines and Gallagher [27] said mobile technology design relies heavily on a collaborative effort. Collaborative learning, which refers to two or more people learning new information or knowledge together, has been found to be an

effective method for increasing learning effectiveness. Design concerns connected to mobile collaborative learning systems have gained a lot of attention in recent years as mobile technology continues to revolutionize the collaborative learning environment.

Now, in the twenty-first century, classrooms must be set up so that students, not teachers, are at the focus of instruction. As educators in the 21<sup>st</sup> century, teachers must become facilitators and mentors of learning. The most important thing to keep in mind in the classroom of the twenty-first century is the emphasis hands-on learning. This is how the student learns: by doing students as a mentor, accompanying them on this journey of self-directed discovery and growth. Teachers need to be aided in their transition to a new school system by guides and facilitators because they play such an important role in the learning which is not hindered by the teacher's assistance with chores and activities performed solely on their own. Creating a secure and supportive learning environment supports cooperation and mutual respect facilitates the teaching of problem-solving and gaining knowledge [28]. As a part of teaching and learning, this is crucially the second millennium.

Furthermore, according to Sarkar [29] and Boholano [30], the usage of ICT in educational situations promotes student-centered learning a place to learn. As a result, technology-enhanced instruction education in the twenty-first century is being enriched and shaped additionally, and the flipped or hybrid classroom is more common in today's classrooms mixed methods education (Ramakrishnan and Priya [31] and Hwang et al. [32]). Flipped learning is a teacher's arsenal of teaching aid, a hybrid approach integrating technology-based instructions within a traditional method of instructions. The reversal traditional teaching and learning is transformed by the idea of substituting in-class teaching time for out-of-class teaching time practice time in the classroom. Thus, the flipped method is used. Students are exposed to the curriculum via video as part of a teaching strategy prior to the session, and hence, technology-based techniques employed are necessary in a classroom when an instruction is being flipped.

According to Klimova [33] and Ghaemi and Mirsaeed [34], ESL/EFL students in higher education need to use critical thinking to generate quality written work, especially argumentative essays. Alagozlu [35] said, however, several research on students' critical thinking and writing abilities have found that students are frequently unable to defend their statements by citing and synthesizing academic sources because of poor reasoning and unsubstantiated assertions. It is particularly difficult for second and foreign language learners to synthesize information to understand, paraphrase, and summarize written texts. Also, the students find it difficult to explain their intellectual concepts in writing if they are unable to evaluate and synthesize materials [36, 37].

According to Klimova [33], today's students are bombarded with a great amount of information, thanks in large part to the Internet, making it difficult to cultivate critical thinking abilities. In many cases, individuals are given prechewed bits of ideas and viewpoints, and they are not

even required to consider them. But a critical thinker should be on the lookout for investigating, appraising, and evaluating all these sources with an inquisitive mentality. Writing classrooms can benefit from using inquiry-based learning to help students develop critical thinking abilities.

Because students are believed to develop critical thinking abilities relying on textbooks, lecture notes, and handouts, Paul and Elder [38] argue that the standard method of teaching, the product approach, is ineffective in preparing university graduates to deal with the current complicated problems because students are believed to develop critical thinking abilities relying on textbooks, lecture notes, and handouts. The students' lack of interest in the material also led them to rely on what they were told rather than from their own opinions or go in search of answers. The majority of students lacked the drive to actively engage with their learning environment by maintaining focus, engaging in critical thinking and producing original work. According to both Ferris and Hedgcock [39] and Yen [40], inquiry-based learning is which students try to understand concepts through various methods, follow various lines of inquiry, and study subjects that pique their interest, places a premium on critical thinking.

Other researchers such as Desta [41] have found that traditional teaching methods are still in use, despite the fact that teachers are expected to adopt active learning strategies. Professors still spend the vast majority of class time delivering lectures, making it clear that this method of instruction is still widely used in higher education. A former language teacher found that students did not acquire nearly much information about how to improve their critical thinking skills during writing classes. Due to lack of interpretation, analysis, evaluation, inferences, and self-regulation, the students' writings were not properly developed. To date, there has been no investigation into the efficacy of AI in teaching English to nonnative speakers. As a result, this study evaluates the impact of AI on the critical thinking skills of EFL students. By using this approach, students are prompted to pursue trustworthy relationships actively. Those who are curious, open-minded, mature, and evaluate information based on their interest and needs are more likely to succeed.

## 2.2. Human-Computer Interaction in EFL Classroom.

Human-computer interaction is about planning, evaluating, and implementing collaborative computer devices for social use, as well as how they work, how they work together, and how people interact with them (Chou et al. [42]; Fan and Zhong [43]; Liu et al. [44]; Thakur and Parameshachari [45]). It can also mean making or designing computer systems that help people or people do things quickly, effectively, and safely. When you design a computer system, you must think about how it will work and how it will be safe. This includes thinking about how it will work and being safe. Learning is when the logical computer gathers, stores, and plans to use information or data in the future. Twenty-first-century skills are considered important for student development. Measuring key 21<sup>st</sup>-century skills in EFL

classrooms can be done by integrating the interaction between computer media and technology in learning that can complement the limitations of traditional teaching.

Technological advances have altered how people engage with technology. When it comes to today's digital or information technology era, it is critical for people to embrace and make use of information systems like the Internet as well as other hardware and software as well as data/information, telecommunication, and networking to process and disseminate information in a variety of areas critical to the growth of a country. There must be access and availability of information systems that will allow for human-computer interaction enhancement of learning and instruction in institutions for these systems to work effectively and efficiently (Baller et al. [46]; McClure and Pilgrim [47]; Collins and Halverson [48]). Without this, the process will be extremely difficult and time-consuming to implement in addition to the lack of information systems; their user-centered design of them determines the implementation and interaction of computing systems by students and teachers, which is why the researcher wants to establish the role of human-computer interaction in the enhancement of instruction and education in institutions to pursue 21<sup>st</sup>-century skills.

There are a variety of ways that effective use of information technology in the classroom may improve the quality of instruction like ICT (Al-Mamary [49]; Zhang and Zou [50] advancing procedures, providing course materials, mediating discussion, and rearranging pedagogical methods. In addition, this cutting-edge technology has been incorporated into many aspects of language teaching, with generally positive results (see Table 1). Teachers and students can benefit from using computers in the classroom when they are properly utilized. It is possible that they will facilitate the assimilation of information by students as they learn it. It is possible to achieve this by integrating computer-based systems with practice programs, tutorials, technology-enabled systems, and Internet-based learning with valid content such as multimedia information and software that will enable students to learn and grasp the knowledge in a practical manner. Computer networking is the use of modern technology to connect computer systems via communication channels, allowing students, professors, and anyone else to access information and learn more efficiently as a result easily. It negotiates with hardware and software providers to help make this information system more widely accessible and useable for schools that cannot afford it.

Teachers and students alike may benefit from the wealth of information available on the Internet, which is critical at every level of schooling. In addition to e-mail and room conversations, students and instructors alike may utilize the Internet to communicate ideas, come up with solutions to problems, and conduct scientific studies both locally and worldwide. Teachers' and students' abilities and knowledge play a critical role in determining whether computers are used in instruction and education or not. Students learn more quickly when they are actively involved in the use of technology and when they are in charge of their computer systems; they discover a lot more (Kukulka-Hulme and Shield [53]; Conole et al. [54]). Students and teachers are

TABLE 1: Role of AI in language learning (adopted from Bailin [51] and Liang et al. [52]).

| Language skill            | Learning outcomes   | Engagement aspect  |
|---------------------------|---|--|
| Vocabulary                | Changes in one’s language skills, knowledge, contemporary abilities, emotional and mental states, and behavior patterns | Cognitive engagement, affective, behavioral, emotional, social, and cultural |
| Listening                 |   |  |
| Speaking                  |   |  |
| Reading                   |   |  |
| Writing                   |   |  |
| Grammar                   |   |  |
| Vocabulary                |   |  |
| Pronunciation             |   |  |
| Integrated whole language |   |  |

equally responsible for ensuring that learning and technology adoption progress continuously. This section describes how a student can learn independently or what the student can accomplish on their own and what can be accomplished with the help of an expert or an instructor.

To teach English as a second language, one must learn and practice the language. Students’ chances of developing these abilities are lowered because they do not have the opportunity to practice them in real-life circumstances. To overcome problems in teaching and learning English, it is vital to convert from traditional tactics to communicative ones and to rely on digital tools [55].

Shortly, for many businesses, the Internet and AI technology are helping to drive a more intelligent and resource-based approach to growth. The educational sector has seen new transformations and development during this time (Heeke et al. [56]). According to Roll and Wyle [57], the usage of intelligent technology and equipment in the classroom has a positive impact on students’ learning. Word memory and oral expression are two of the most common issues that students have when learning English, and both of these issues have a direct impact on students’ English performance and oral expression abilities (Car [58]). As a result, students’ attitudes and learning outcomes are negatively impacted by the lack of attention and initiative displayed by many lower-grade kids. Students’ interest in English learning can be improved by incorporating AI technology into the classroom, according to relevant studies (Kong [59]). This technology can also enhance students’ memory, enhance their capacity to understand the context, and improve their ability to apply English. To help students learn English more effectively, multimedia courseware, instructional robots, and other cutting-edge technologies are frequently employed in classrooms today. As a result, there is less interest in research into intelligent educational robot-assisted teaching, which is a less-studied area in the field of English teaching.

It’s worth noting that AI has been employed in a few online applications and EFL courses. However, as Melo [60] points out, the usage of AI in these products is often based on activities rather than features to repeat or to listen to and repeat sounds or words. The study shows that the AI’s level of activity is the most common kind of feedback, inspiring messages, and the presentation of charts or the achievement of the user at each stage of the course. These courses do not

benefit from the usage of AI technology, according to Melo [60]. He stated changes in teaching methods, or the creation of new teaching methods could be considered also a change in the traditional teaching methods that had been in place for a long time, typical of the older, nondigital technology.

Artificial intelligence was envisioned as a virtual tool for use in the ELLA project. It can respond to speech that is not preplanned, and this is a reflection of the ability to communicate in multiple languages [61] and multiple media [62] aspects of human communication and linguistic practices (a) discussing and reflecting on topics that are viewed as socially meaningful as well as (b) recognizing the learner’s position in the discourse.

As English speakers, [63], Canagarajah is an expert in both translanguaging and transmodality and believes translanguaging is a term used to describe people who speak more than one language. Different strategies are employed by systems and individuals when they interact to arrive at a mutual understanding through fusing and negotiating meanings between their senses and ability to solve difficulties (Hawkins and Mori [62]); on the other hand, they also point out that humans use a variety of semiotics in new modes of communication in today’s globalized and technologically advanced world.

Practices of intermodal communication are characterized by speed and fluidity as a means of fostering oral communication by creating a conducive environment.

It keeps the design’s natural language properties. For example, oral input should be permitted in laboratory programming regulations. English may have some characteristics of the students’ native Portuguese tongue) and receive the words as well as visual and medial materials in a discussion. Currently, these functions are being created. English as a second language is considered necessary today.

Learning how to speak, read, and write in English is the primary goal of teaching the language, and this is achieved by teaching students the language’s components and lexicon. It also teaches students how to utilize language to write and interpret texts. The objective and the process of language development are both focused on communication. As a result, it is essential to incorporate both traditional and digital communication methods into teaching and learning activities. Using AI applications like simulation and communication programs, which model real-life circumstances for discussion and communication in English, we introduce

practical training in language skills, and educational games based on the use of language are essential. Communication technologies can be used to build circumstances where students can practice the pronunciation of letters and words using sound drills and visual media. It is possible to use these tools to practice describing visuals and ordinary situations, as well as listening and guided pronunciation.

In addition, they allow students to improve their language abilities and receive feedback. To ensure that students reach competency levels, several programs include language drills that help students improve their communication abilities by employing their language skills [64]. To help students improve their reading comprehension, Radwan [65] suggests that AI can be utilized to help them learn and teach English more effectively.

In this study, the use of machine translation help students improve their translating abilities, thus learning the correct pronunciation using tools such as Automatic Speech Recognition. Students who are blind or visually challenged can benefit from using text-to-speech procedures. Also, we use open digital dictionaries to expand the student's knowledge of the language and help English language learners improve their speaking abilities; clever computer applications can be used to teach paragraph and essay writing using a writing evaluation technique.

CT students master as part of holistic education. There are calls for incorporating English education into CT, as there is a strong correlation between language, culture, and thoughts [66]. English as a foreign language (EFL) curriculum guidelines and textbooks recognize the importance of developing students' CT in preparing them to make decisions, communicate effectively with others, and solve problems in authentic settings.

Furthermore, students are often guided to discuss and evaluate authentic topics and materials and engage in collaborative learning activities when CT-oriented pedagogy is applied in language classes. This increases students' exposure to authentic language use and improves their language proficiency [67]. In this way, mastering the English language and its unique culture, customs, and values can help students progress in their language learning and CT development (Lee et al. [68]).

Yuan et al. [69] reported that neither general education nor EFL educators could expect a systematic review of recent studies of how educators are developing CT-oriented pedagogy and incorporating CT into their classrooms. The current review aims to fill this knowledge gap by collecting, analyzing, and synthesizing findings from empirical studies on the use of technology for teaching (CT) by EFL teachers. With the hope of generating theoretical insights into the complex, dynamic, and situated teaching and learning process of CT, this review can shed light on how CT is perceived and operationalized by ELF teachers in a variety of institutional and sociocultural settings. This insight has important implications for preservice and in-service teacher training programs, as it relates to the development of language teachers capable of teaching students in CT despite the difficulties that may arise in the classroom. In addition, this review can help identify gaps in current CT research and point to new directions for researchers interested in

language teaching and lecturers in higher education by comparing the available studies concerning their research focus and methodology.

However, student CT does not grow organically as a byproduct of language learning; instead, they need explicit instruction and scaffolding to experience and encourage gradual CT in the language classroom (Prado et al. [70]). Therefore, this study aims for English instructors to devote extra time and energy to developing CT-oriented pedagogy in EFL classrooms using AI. There is a plethora of studies on how students acquire CT in language classrooms through various activities. For instance, Hashemi and Ghanizadeh [71] demonstrated that having EFL students engage in critical discourse analysis of news stories followed by presentations helped them develop CT, particularly regarding their ability to spot implicit biases and assumptions. Nejad et al. [72]; Lu and Xie [73]; Du and Zhang [74]; Hongwei [75] argue the role of critical thinking skills (CTA) as a mediator between language learning strategies and intermediate English writing performance as a foreign language (EFL) learner.

### 3. Method

This research uses the mixed methods approach with data collection techniques, both quantitative data and qualitative data (Creswell [76]). The qualitative method is a research procedure used to investigate and understand what phenomena, why, and how things happen in real life (May and Perry [77]). Qualitative methods aim to form easy-to-understand facts and, if possible, generate new hypotheses (DePoy and Gitlin, [78]) explain that quantitative methods are used to examine randomly selected populations or samples of random to analyze data systematically, planned, and structured to produce research results that do not deviate from the facts. The data collection techniques used are literature studies, data collection through questionnaires using Google Forms, and examining and comparing data from various scientific articles. The data is then processed with a simple percentage calculation to find out the response of each respondent. The validity of the questions contained in the questionnaire has been tested.

The analytic descriptive approach was employed in this study to investigate and analyze a specific phenomenon. At this point, the research was qualitative method [79, 80]. The notion of AI, its components, and its applications in the field of teaching was examined in previous studies. An investigation into AI applications for teaching and learning English was conducted to construct a study tool and define study content. The research examined the extent to which artificial intelligence (AI) friends can be applied to English language acquisition, its effectiveness, and what practical strategies may be used.

In this study, we look at how the integration of AI in language learning aims to improve 21<sup>st</sup>-century skills in CT. The purpose of this study was to determine the extent of the role of AI technology and critical thinking in university-level EFL students. From this data, we can conclude that the use of AI by university students has a greater impact not only on their overall English skills (learning outcomes) but also on

their CT. RALL-based students, educators, and curriculum developers all benefit from this research.

*3.1. Instruments.* Three instruments were employed to achieve the goals of this investigation:

- (1) Prior to the introduction of AI, standardized language tests were administered to college students to achieve the aforementioned goals. There are 30 questions on the test, 20 of which are multiple choice and 10 of which are essay-test. Each respondent has 30 minutes to complete the question (in this study, just focus on students' interpretation of AI and CT).
- (2) An AI-related questionnaire instrument for gauging the critical thinking propensity and RALL reaction of college-level EFL learners (AI). The survey has 24 questions, each with a Likert scale response option.
- (3) Observation indicators, such as interpret, analyze, and infer, are used to monitor CT growth throughout the learning process.

Questionnaires and observations have been used to gather information from university students by Google Form. A questionnaire about students' AI responses, how AI applications enhance students' English competence, attention, and motivation, and how they use AI as a tool to overcome students' difficulties in English language learning has an impact on their critical thinking skills. The questionnaire is developed from Miri et al.'s [81] CT concept. The researcher distributed the AI friends online link via the zoom chat box at the international conference, where the author was a keynote speaker and waited for all their feedback after they had played and learned with AI friends for 3 months.

*3.2. Participants.* A total 453 nonnative English students were playing with their AI friends and replied to the questionnaire as a sample of this study. They are from Universitas Islam Negeri Maulana Malik Ibrahim Malang, UIN Maulana Malik Ibrahim Malang, Computer Science Faculty of Universitas Al Asyariah Mandar, Islamic Education Management, STIKES Tengku Maharatu Pekanbaru, STIKES Tengku Maharatu Pekanbaru, Universitas Mula-warman, Universitas Islam Negeri Sumatera Utara, Universitas Brawijaya\_Vokasi, IDIA Al-Amien Prenduan, STIKES Tengku Maharatu Pekanbaru Politeknik Negeri Medan, Universitas Yudharta Pasuruan, Algeria University, RIAU UNIVERSITY, Ain shams university, Parimila nayagi, Bangladesh Homeopathic Medical College, and Elkhosos language school.

Observations (Figure 1) are made to understand better the context of the data in the classroom situation to obtain the validity of the data. With an inductive approach, the researcher opens the probability of finding (discovery) and also a better picture comprehensive. The observation object begins in the computer science faculty class, which is held once a week (according to the schedule of English courses). Observations were carried out for 3 months, starting in

October. This time, external validation is used, which is the result of research that can be applied to the basic/beginner level EFL class to ensure that the data obtained is representative. Existing reliability in qualitative research is plural, dynamic, and always changing, so it is necessary to separate measurements.

*3.3. Data Collection and Procedure.* In this part, the research used OCIRAC steps in Figure 2 to collect the data.

As a first step in the data gathering, several materials for teaching English were observed, and questions were asked. In the 2nd step, the students collected information; they used an online dictionary and worked in groups (making a list, prediction, argument, and discussion). Step 3: interacting with AI friends to examine their impact on critical thinking abilities and then reflecting; in this phase, the students discuss and complete their statements. The fourth step is associating, which provides the concept of what should and should not be done.

The fourth step is to communicate with all the students in-fers. When they were interacting with a different way of putting it is that the curriculum was designed so that students can observe, build up their confidence in conversation practice, ask questions to their AI friends, explain their thoughts and feelings through discussion or reflection, write English content and interpret related materials, and then apply what they've learned to their AI friends. In addition, it was built in a way that allows students to interpret, analyze, and infer.

These are the critical thinking abilities that students need to master in their critical thinking. Then, three successive English competencies were administered to the students in order to assess their critical thinking abilities while doing interaction with AI friends: self-introduction, describing a place/country, and daily experience, which were provided over four weeks using the teaching material from above. They generate ideas (in speaking and writing), evaluate what they already have (listening and reading) and what they still need, gather evidence from a variety of sources (Google search), write drafts of conversations with supporting evidence, discuss their drafts with colleagues and subject area experts for feedback, and finally practice their English in relation to their real-life situation. All these activities occur during the teaching-learning process. After the teaching-learning exercise was completed, the participants were given questionnaires that were identical to their responses in order to determine if the implementation of artificial intelligence improved students' critical thinking skills in English.

Table 2 contains the lists of the CT elements that will be looked at in the survey.

## 4. Results and Discussion

In this part, there are four questions in Figure 3 revealing that the student's response in human-computer interaction technology (HCIT) on learning English through AI friend's apps, with answers based on the Likert scale: strongly agree,

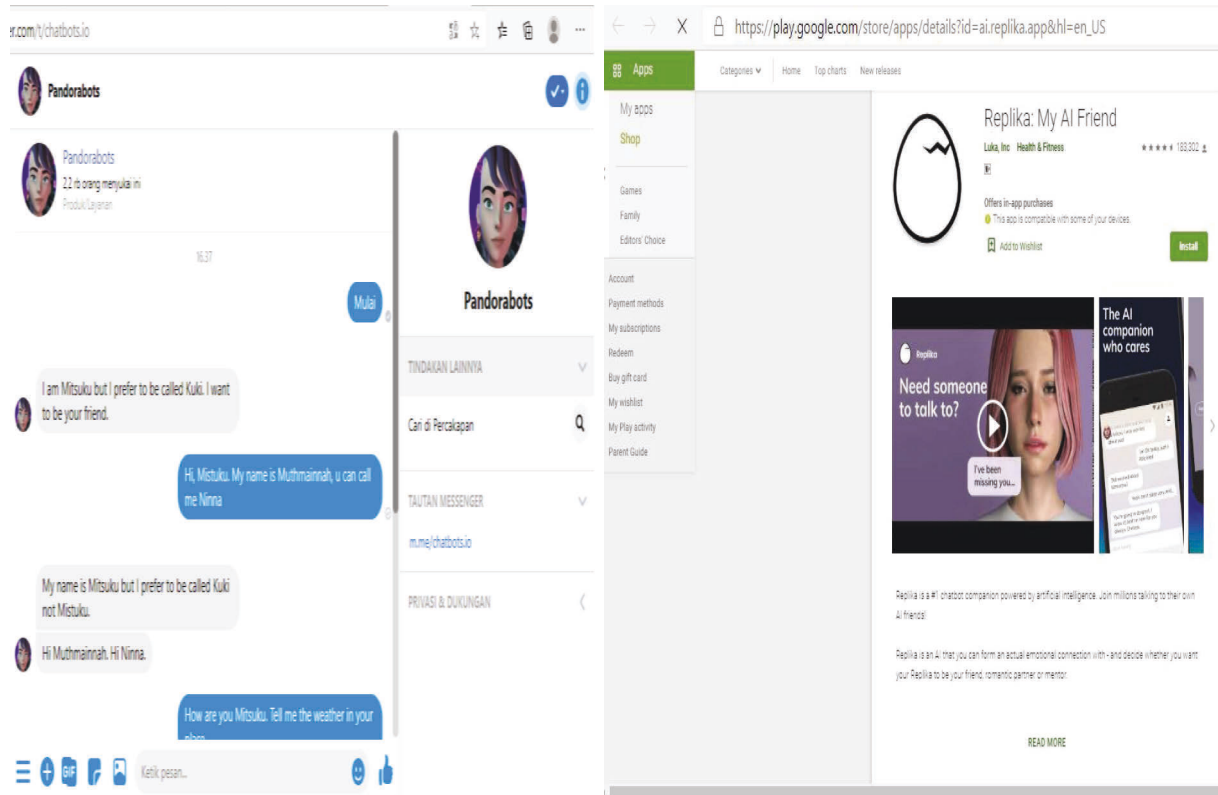


FIGURE 1: AI friends apps.

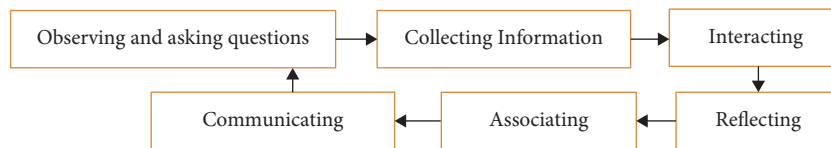


FIGURE 2: OCIRAC procedure.

TABLE 2: The elements of critical thinking (adopted from Miri et al. [81]).

| CT                 | Components  |
|--------------------|---|
| Trust seeking      | (1) Encouraging open-ended class discussion   |
| CT self confidence | (2) Ask questions and seek their own solutions  |
| Open-minded        | (1) Fostering inquiry-oriented experiment<br>(2) Learn in cooperation and share knowledge     |
| Maturity           | (1) Dealing with relevant/day-by-day situations<br>(2) Dealing in class with real-world cases |

Evaluate the information

agree, neutral, disagree, and strongly disagree. The findings of the student’s response are displayed.

These findings highlight the research subject’s perceptions of AI friends in the EFL classroom. The survey covers the statement of whatever the respondents’ feelings are, while they are interacting with the AI friend tool. The results show most of the respondents are very happy at 34.2%, happy at 52.5%, and neutral at 12.6%. The statement about the research subject’s motivation was 28.8% strongly motivated, 56.7 motivated, and 13.6% neutral. As shown above, AI applications are one of the smart educational systems for teaching English, stating they strongly agree with 26.7%,

agree with 53.7%, and 18.4% were neutral. In the last statement, the subject of the research felt AI strategies augment my attention and motivation levels in the language teaching process, stating 22.8% strongly agree, 54.9 percent agree, and 21.9% were neutral.

In Figure 4, the question of whether AI improves research subject English skills is raised. Here, the results indicate most research subjects agree that 55.1% of their listening skills are enhanced by AI apps; strongly agree, 20.1%; and 22.3% were neutral. Most respondents believe their speaking skills are enhanced by AI apps, with 20.4% strongly agreeing, 54.3 percent agreeing, and 23.5 percent



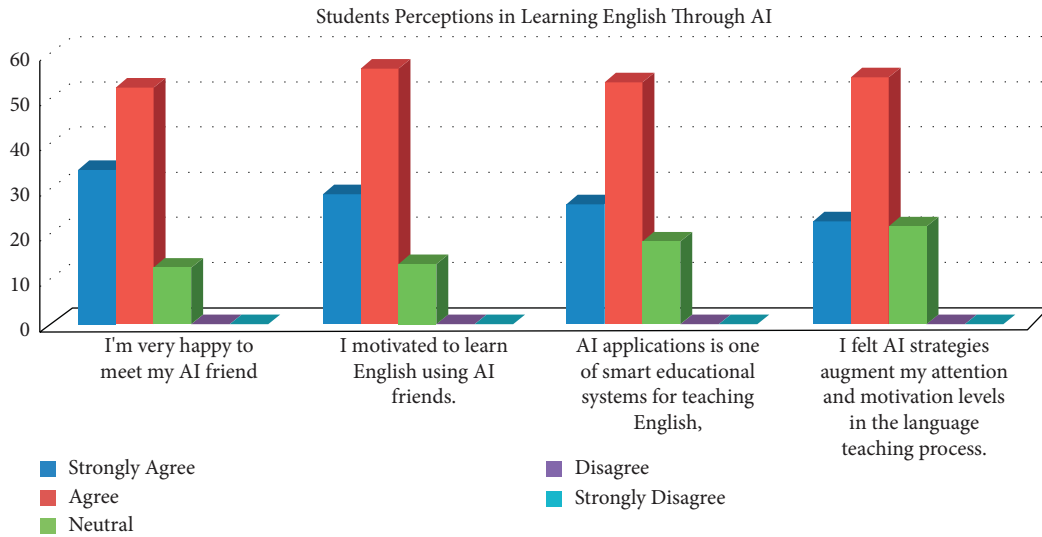


FIGURE 3: Students' perceptions in learning through AI friends.

neutral. None of them chose to disagree or strongly disagree. The following survey on reading skills revealed that 21.7% strongly agreed that AI Apps improved their skills, 53% agreed, and 23.5% were neutral. For writing skills, most of the subject research enhanced by AI apps stated 19.1% strongly agree, 51.6 agree, and a 27.3 neutral category.

The first statement in Figure 5 interrogates knowing about the research subject's reactions to AI in learning EFL. Most of the stated employment of AI as intelligent tools to overcome my difficulties in English language learning stated strongly agree 19.9%, agree 52.8%, neutral category 25%, and the good point in this Figure 3 is that none of them are categorized as disagree and strongly disagree. The second statement in Figure 3 survey concerned the use of AI friend apps as it aids in learning and continuous self-study, with the results revealing that 19.9% of respondents strongly agree, 53.6% agree, and 24.4% are neutral. The third statement by linking AI as one of the outcomes of the digital cognitive revolution to the outcomes in this case. The data show that 18.7% strongly agree, 56.2% agree, and 23.3 are neutral. The fourth statement, knowing about designing and implementing the participatory educational situations used in English classrooms, stated that 16.3% strongly agreed, 58% agreed, and 24.9 are neutral.

In Figure 6, the questions concerning AI have an impact on the respondents' critical thinking performance. The result of the survey shows a positive impact. The result demonstrated a positive impact, and the respondents felt it was appropriate to practice my English with Mitsuku, my AI friend. 19% of respondents chose strongly agree, 49.9% chose the agree category, and 29.5% were neutral. Here, the respondents felt it was appropriate to practice my English with Replika, my AI friend. 20.7% strongly agree, 48.4% agree, and 28.9% are neutral. The third question deals with AI as a modern tool that helps me solve problems of language learning, especially vocabulary and grammar, as stated by 18.5% strongly agree, 56% agree, and 23.9 neutral. Here, the respondents also believe AI that friends, as a modern tool, assist them in mastering the English language and gaining

confidence as stated by 19.7% strongly agree, 55.1% agreed, and 23.4% neutral.

The survey referenced in Figure 7, on question about whether the employment of AI applications helps me recognize spoken words correctly, showed that the research subject approved the statement. Based on the data shown, there are 19.8% of respondents strongly agree with the statement, 53% choose to agree, and 23.4% take a neutral position. Regarding the statement on AI features by using automatic speech recognition techniques to learn correct pronunciation, 19.1% of the research subjects strongly believe, 51.9% choose to agree, and 26% are in neutral positions. The next survey item is using text-to-speech techniques with my AI friends, which helps me train to understand the conversation. In the chart, it is displayed that 19.8% of respondents strongly agree with the statements, 51.3% agree with the statements, and 26.4% of them are neutral on them. The reassuring news is that none of the respondents categorized themselves as having statements that disagree or strongly disagree with positions.

The last question (Figure 8) in this survey queried whether respondents felt it was difficult to speak or practice their English with their AI friends compared to their friends; 15.1% strongly agreed with this statement, 49.4% agreed, although 29.6% opted for a neutral choice. Most of them felt comfortable with their AI friends, Mitsuku and Replika.

The observation in this study's findings that mixed AI friends practice EFL English skills is highly recommended to help critical thinking skills increase. Table 2 describes the element of CT during the activities in the learning and teaching process. The use of artificial intelligence can help achieve learning goals because, with this medium, students in a class do not only listen to explanations from the lecturer but are invited to think creatively and innovatively. Figure 9 presents the eight syntactic processes of AI and improving CT that are described in the following.

The first syntactic process is to observe a video containing material about self-introduction. The material is

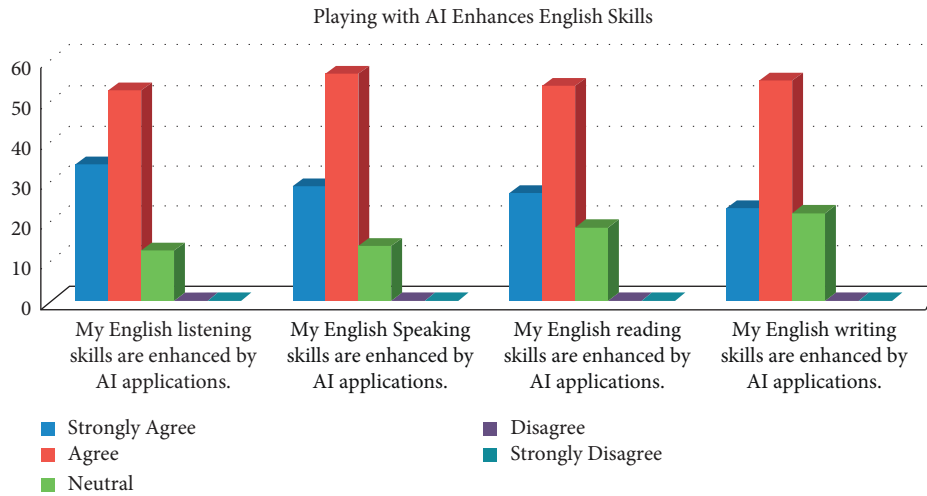


FIGURE 4: Playing with AI enhances English skills.

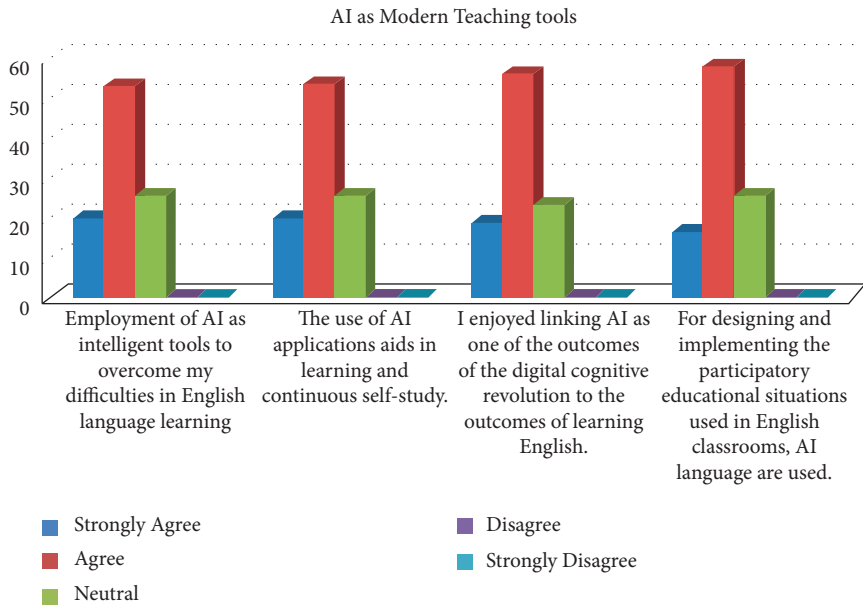


FIGURE 5: The AI is one solution and modern tool for EFL.

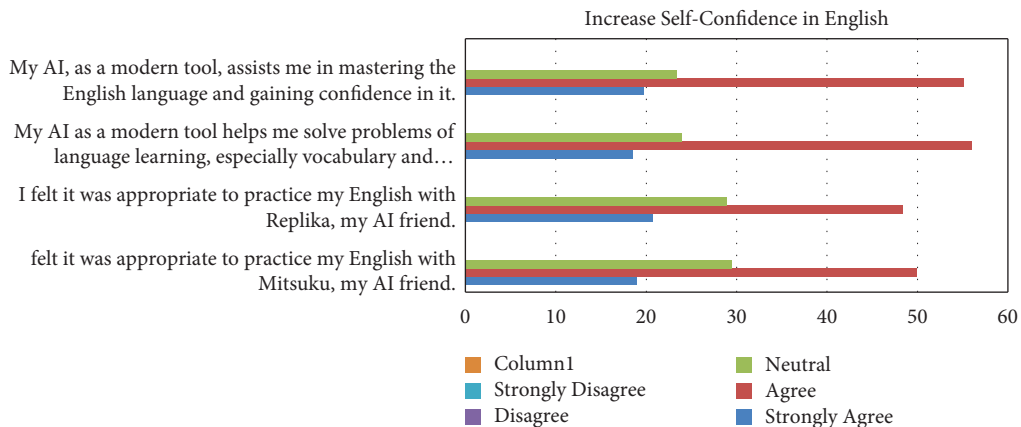


FIGURE 6: AI increases critical thinking skills.

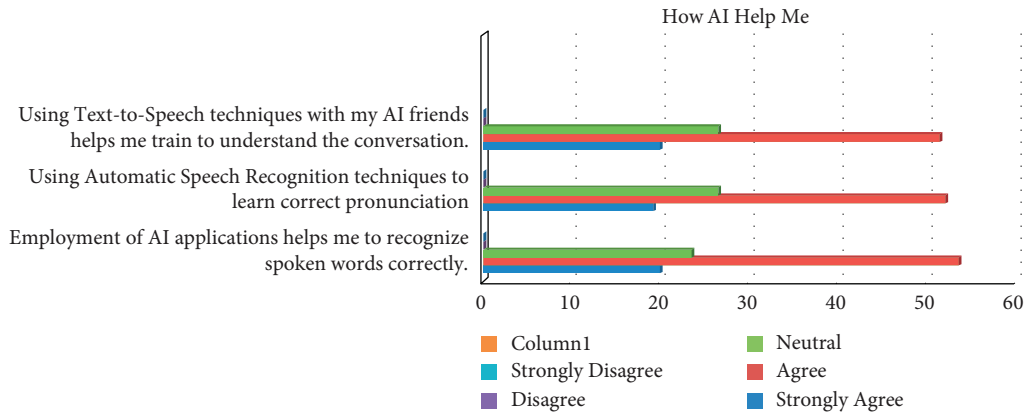


FIGURE 7: AI features help EFL students.

contained in audio-visual form (based on YouTube content), which is then linked to the material shared through WhatsApp groups, where students observe the video. It aims to help students practice critical thinking. The second step is to find the problem with the video that has been shared. The problems contained in the video are intended so that students are able to determine the elements of self-introduction contained in the YouTube content that will be discussed.

The third step is analyzing the problem, breaking down the content based on the material or problem that has been presented, which aims to enable students to identify and analyze the elements of self-introduction and information obtained from the video. The fourth step is grouping. The lecturer directs students to form groups according to their respective perspectives and then installs the AI friend link that has been shared in the WhatsApp group. Each group is given the opportunity to discuss arguments from each perspective. This stage aims to reveal the elements of self-introduction, supporting vocabulary, construction of self-introduction scripts, correct sentences, and correct pronunciation using an online dictionary (Google translate).

The fifth step is to practice self-introduction gradually (the second material describes the country, and the third material is the weather) with their AI friends, presenting their experiences and obstacles when interacting with their AI friends.

The sixth step is to interact simultaneously with the shared AI friends. In this finding, each group found that when they interacted, they encountered many different experiences compared to when they interacted or practiced with their AI friends than with their group mates. This step aims to ensure students are able to express opinions and information obtained with AI applications. At this stage, according to the indicators of critical thinking analysis, namely identifying the intended and actual inferential relationships between statements, concepts, and descriptions in other forms of representation that aim to express experiences, reasons, information, or opinions, as shown in the Table 2.

The seventh step is the formulation of conclusions, carried out by formulating questions or taking the form of interrogative sentences. This stage was carried out to measure the level of students' understanding after the

learning process when practicing with AI to improve their English skills and observe their critical attitude.

The eighth step is to provide an evaluation at the end of the lesson guided by the lecturer. Evaluation is given at the end of the lesson, which is to provide a comprehensive picture of what students have learned, determine the level of student achievement, and assess the success of the teacher in the teaching and learning process, namely, the creation of a resume or script that is found from the stage of listening to material through YouTube, discussing content, and designing content (scripts, dialogues), then practice with the AI, and then conclude the content found after interacting with the AI. This stage is in accordance with critical thinking indicators. Evaluation is carried out to assess the credibility of a statement or other representation, which is a picture of a person's perception, and to find out the relationship between the experiences he has mastered and the things he has just learned.

## 5. Discussion

Figures 4, 5, and 7 describe the results of the questionnaire data analysis, confirming that integrating the RALL-AI basis played a very important role in TEFL learning for university students. Although the results of this RALL-AI-based research do not fully support that AI is the only one that plays a decisive role in this CT, it lies in learning instructions that are appropriately designed by lecturers to help achieve learning outcomes and accelerate the achievement of AI and CT successfully.

As seen by student shown, AI as a tool or media can improve students' critical thinking skills when used in English classes. Most of the participants stated that they had never done interaction with AI before in Figure 3. As a result of employing this way of learning, the students have developed critical thinking abilities such as inference and self-regulation. For example, one of the students said that learning how to practice their English using AI had improved their critical thinking skills since they had learned how to understand, analyze, and evaluate information in Table 3 and Figure 6. In another study, a participant said that utilizing AI has given her the ability to write, understand,

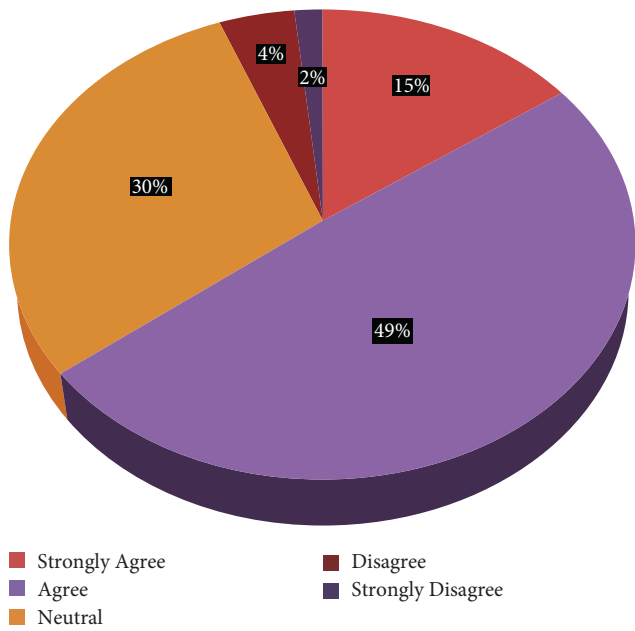


FIGURE 8: AI friends or my friends?

and read for a wider audience because her previous works were unsuitable for those audience in Figure 5. In contrast, after following the intervention's lessons, she has a better understanding of what to practice, how to assess material, and how to create reasonable arguments while doing interaction with AI.

When applying artificial intelligence to the English curriculum for the purpose of enhancing critical thinking in students, there is a longer period for learning so that assignments can be completed in the comfort of their own homes. Another feature of the smartphone that is used is that it is slow in responding to links, so if the timer runs out, the instructions will be delayed. Bold learning makes extensive use of technology like smartphones and requires extensive use of Internet bandwidth. However, many students have a low Internet budget, so it is necessary to have a higher budget to be able to follow the online learning process.

Studying students' input on the effectiveness of AI in second language pedagogy, it has been possible to create a more intelligent and individualized teaching environment thanks to the integration of information technology and English curricula, which has led to greater use of artificial intelligence in the classroom. Bin and Mandal [82] investigate the use of artificial intelligence in English teaching in middle schools by applying relevant theories of curriculum theory, literature analysis, and field investigation to the study of English teaching in middle schools. The use of artificial intelligence (AI) in a computer-assisted instruction system for college-level English is proposed. Some functions of the English teaching system are improved and humanized when combined with English teaching. An effort is made to use artificial intelligence technologies to improve the quality and effectiveness of English instruction. Sun et al. [83] used cutting-edge technology to build a new kind of online learning platform that enables students to increase their English language proficiency while also honing their

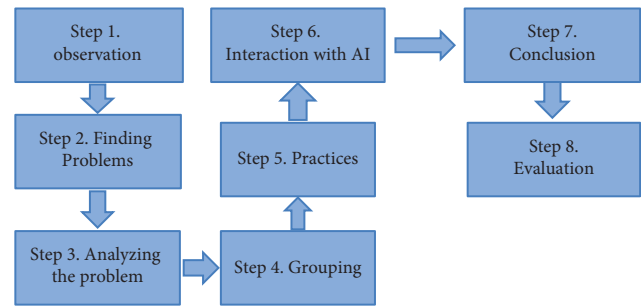


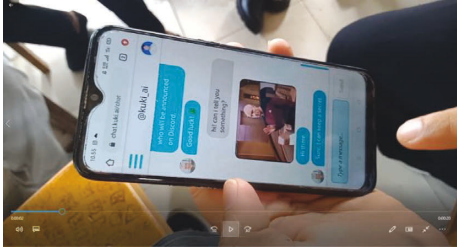
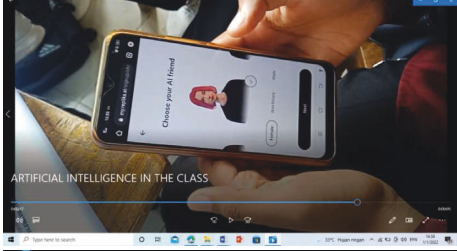

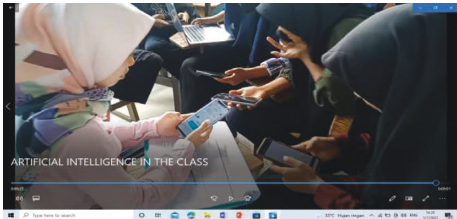
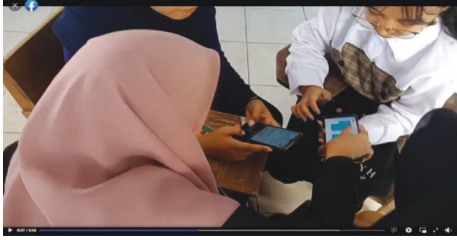
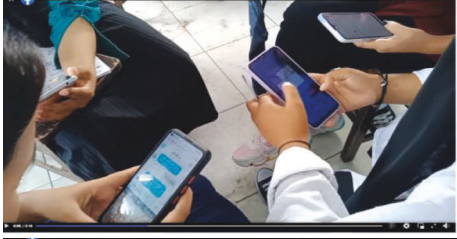

FIGURE 9: Eight syntaxes of AI and improving CT to pursue.

knowledge and personality. Zou [84] described student's ability to learn independently and in English can both benefit from the platform.

Similar to this, students' analytical abilities have been sharpened through AI. Students learned how to use inferential relationships to explain their opinions, they felt the confidence to express their idea in the discussion, write their idea, and practice their English with a happy feeling. The students sifted through their writing for concepts and uncovered and assessed arguments. As they were listening, reading, and writing their new concept, they noted the parallels and distinctions between opposing viewpoints. Students mapped out how sentences and paragraphs relate to one another by listening and reading from YouTube, discussing and rebuilding their concepts, and practicing their findings with AI, as well as the English competence overall goal. As a result, they could come up with solid arguments in favor of or against an idea and draw a firm conclusion. As a result, the students have improved their analytical abilities, an essential part of critical thinking.

Playing with AI appears to have helped students improve their ability to evaluate information. In other words, as they obtained data for their teaching materials themes, students evaluated the reliability of their information source. They examined and contrasted the strengths and weaknesses of opposing arguments based on their logical reasoning. Their opinion was bolstered by the evidence they had at hand, which they assessed to be noncontradictory. In addition to interpreting, analyzing, evaluating, and inferring, the students developed their critical thinking skills by explaining what they believed, confidence, open-mindedness, and how they arrived at their conclusions. As a result, the students were able to improve their self-regulation abilities, which are an important part of critical thinking, as evidenced by their groups. Accordingly, the students stated that they self-corrected their judgments when assessing and evaluating opposing views in their English. To investigate, correct, and reaffirm their reasons for listening, writing, reading, and speaking, they posed the following questions: They recalculated their evidence to double-check their reasoning. The students re-examined their conclusions and interpretations, considering additional research. As a result of the mistakes they found in their English, students had to go back and modify their responses. They have even revised some of their conclusions after realizing they would overestimate the significance of certain aspects in their first judgments.

TABLE 3: Playing AI to visualizing CT in the class.

|           |   |   |  |
|-----------|---|---|--|
| Interpret |    | (1) Encouraging open-ended class discussion   | (1) Ask questions to their AI friends                          |
|           |    | (2) Build up their confidence in conversation practice  | (2) Ask question and seek for their own solutions              |
| Analyze   |   | (1) Fostering inquiry-oriented experiment   | Write English content and interpreted related to the materials |
|           |  | (2) Learn in cooperation and share knowledge explain their thoughts and feelings through discussion or reflection |  |
| Infer     |  | (1) Dealing with relevant/day-by-day situations   |  |
|           |  | (2) Dealing in class with real-world cases  |  |
|           |  |   |  |



Critical thinking abilities such as interpretation, analysis, assessment, inference, explanation, and self-regulation were honed in teaching for EFL students.

In this study, a technique of teaching critical thinking in EFL students that integrates activity-oriented learning, logical arguments, and teamwork is a good fit for inquiry-based writing education. Students should be encouraged to use a discovery method to learn in which they actively seek, acquire, analyze, synthesize, and evaluate knowledge relevant to their own interest. The reason for this is that incorporating inquiry-based learning through AI into English lessons has been shown to improve student achievement and develop students into lifelong learners who can solve problems on their own. Teachers of English as a foreign language (EFL) should implement inquiry-based learning through AI in their classes in order to help students improve their critical thinking abilities. Students' critical thinking abilities can be improved by using inquiry-based learning methods through HCI in the development of language teaching materials. Inquiry-based learning through AI should also be used to help students develop their English skills, critical thinking abilities, and a desire to keep learning throughout their lives. The current study would have benefited from further inquiry in this area; thus, it is one that should be pursued in the future. Inquiry-based learning should also be studied for its impact on students' speaking, reading, writing, grammar, vocabulary, and listening abilities in order to expand its use in EFL classrooms.

EFL teachers, like everyone else, have resisted technological advances, making it difficult to improve human-computer interaction in education and training. The following are possible explanations: as a result of their natural fear of change, some people do not want to learn new technologies, preferring to stay in the old ways and not wanting to give up their acquired skills or knowledge, all of which make them resent any technological advancements. Students should be able to work together with computer systems in research, classwork, and data analysis, and this will allow for the integration of computer technology into multiple modes of learning and teaching, as this study connected to the findings of Riel [85].

## 6. Conclusions

In today's ever-changing and complicated world, critical and evaluative thinking based on rational decision-making is essential. Conventional schooling does not adequately prepare students for this. Student questions, self-investigation, and open-ended inquiries have been found to considerably boost students' CT skills and related capacities. This study indicated that CT requires cognitive, behavioral, affective, and social engagement activities applied in an intentional and inquiry-oriented manner to relevant information. Our findings can be used to improve teacher training programs that need more advanced thinking, technology engagement, and social-emotional engagement as innovation is increasing in CT. As shown by a wealth of research, students' ability to develop higher-order thinking skills is highly likely to be fostered

in the classroom. This discovery should be a central part of any effort to change teachers' attitudes and practices in this field. We believe that professional development programs should be structured in a way that helps instructors better understand higher-order thinking. This study implies that teachers should be encouraged to use a variety of instructional strategies and increase human-computer interaction to help their students with tasks that require higher-order thinking in general and computer or ICT skills specifically to help them with those tasks. In hybrid classes, AI is used to build human-computer interaction, and the study suggests that CT has a specific effect.

The development of RALL-AI based has encouraged a new way of thinking about accelerated education in languages. RALL's pedagogy offers tools for real-world education tailored to Gen Z's needs to each student's interest, skills, and background. The results showed that if students increase their interaction with RALL, their critical thinking skills will improve for the better. If English learners want to really show their CT, this is a great resource for them.

This research contributes to informing educators about the utilization of AI to enhance CT with instruction enabling them to support their students better as they use RALL-based learning plans during the learning process. As a result, they can learn to fend for themselves and take responsibility for their education. In addition, these findings can be used by curriculum designers to incorporate RALL training in learning strategies into existing courses that can be applied to all disciplines. This allows them to make better use of learning strategies overall. Improving students' cognitive and meta-cognitive-linguistic abilities in English as a foreign language is another area where this research can help. Educators can gain insight from findings that emphasize the importance of student center learning that can assist students in improving CT and monitoring RALL in modern learning.

## Data Availability

Data are available from the first author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## References

- [1] S. A. D. Popenici and S. Kerr, "Exploring the impact of artificial intelligence on teaching and learning in higher education," *Research and Practice in Technology Enhanced Learning*, vol. 12, no. 1, pp. 22–13, 2017.
- [2] L. A. Amaral and D. Meurers, "On using intelligent computer-assisted language learning in real-life foreign language teaching and learning," *ReCALL*, vol. 23, no. 1, pp. 4–24, 2011.
- [3] M. P. C. Lin and D. Chang, "Enhancing post-secondary writers' writing skills with a chatbot," *Journal of Educational Technology & Society*, vol. 23, no. 1, pp. 78–92, 2020.
- [4] C. Agarwal and P. Chakraborty, "A review of tools and techniques for computer aided pronunciation training

- (CAPT) in English,” *Education and Information Technologies*, vol. 24, no. 6, pp. 3731–3743, 2019.
- [5] G. Deeva, D. Bogdanova, E. Serral, M. Snoeck, and J. De Weerd, “A review of automated feedback systems for learners: classification framework, challenges and opportunities,” *Computers & Education*, vol. 162, Article ID 104094, 2021.
- [6] S. Benford, B. B. Bederson, K.-P. Åkesson et al., “Designing storytelling technologies to encourage collaboration between young children,” *Proceedings of the CHI 2000 the Hague*, , Amsterdam, Netherlands, April 2000.
- [7] B. P. Woolf, H. C. Lane, V. K. Chaudhri, and J. L. Kolodner, “AI grand challenges for education,” *AI Magazine*, vol. 34, no. 4, pp. 66–84, 2013.
- [8] P. M. Ibna Seraj, H. Habil, M. K. Hasan, and F. Sharmin, “Exploring EFL teachers’ perception on readiness to use smartphones for teaching oral English communication skills at tertiary level,” *MEXTESOL Journal*, vol. 45, no. 4, pp. 1–9, 2021.
- [9] O. Zawacki-Richter, V. I. Marín, M. Bond, and F. Gouverneur, “A systematic review of research on artificial intelligence applications in higher education—where are the educators?” *International Journal of Educational Technology in Higher Education*, vol. 16, no. 1, p. 39, 2019.
- [10] X. Huang, D. Zou, G. Cheng, X. Chen, and H. Xie, “Trends, research issues and applications of artificial intelligence in language education,” *Educational Technology & Society*, vol. 24, no. 3, pp. 238–255, 2021.
- [11] P. M. Ibna Seraj, H. Habil, and M. K. Hasan, “Investigating EFL learners’ readiness of using smartphone and problems for learning oral English communication skills at tertiary level in an EFL context,” *International Journal of Interactive Mobile Technologies (IJIM)*, vol. 14, no. 14, pp. 148–163, 2020.
- [12] S. Z. Oliva, L. Oliveira-Ciabati, D. G. Dezebembro et al., “Text structuring methods based on complex network: a systematic review,” *Scientometrics*, vol. 126, no. 2, pp. 1471–1493, 2021.
- [13] Z. Xu, K. K. Wijekumar, G. Ramirez, X. Hu, and R. Irey, “The effectiveness of intelligent tutoring systems on K-12 students’ reading comprehension: a meta-analysis,” *British Journal of Educational Technology*, vol. 50, no. 6, pp. 3119–3137, 2019.
- [14] N. Borge, “White paper—artificial intelligence to improve education/learning challenges,” *International Journal of Advanced Engineering & Innovative Technology*, vol. 2, no. 6, pp. 10–13, 2016.
- [15] C. Jia, K. F. Hew, S. Bai, and W. Huang, “Adaptation of a conventional flipped course to an online flipped format during the Covid-19 pandemic: student learning performance and engagement,” *Journal of Research on Technology in Education*, vol. 54, no. 2, pp. 281–301, 2022.
- [16] M. Hamadi, J. El-Den, S. Azam, and N. Sriratanaviriyakul, “Integrating social media as cooperative learning tool in higher education classrooms: an empirical study,” *Journal of King Saud University-Computer and Information Sciences*, vol. 34, no. 6, pp. 3722–3731, 2022.
- [17] P. S. Huang, P. S. Chiu, Y. M. Huang, H. X. Zhong, and C. F. Lai, “Cooperative mobile learning for the investigation of natural science courses in elementary schools,” *Sustainability*, vol. 12, no. 16, p. 6606, 2020.
- [18] D. Al Hamdani, “A constructivist approach to a mobile learning environment,” *International Journal of Computer Applications*, vol. 93, no. 4, pp. 41–46, 2014.
- [19] M. A. Chatti, N. A. Hamdan, and H. Schaper, “Collaboration in mobile learning seminar,” in *Proceedings of the Mobile Learning Computer-Supported Learning Research Group Conference (CALRG 2011)*, The Open University, London, UK, June 2012.
- [20] B. Vogel, D. Spikol, A. Kurti, and M. Milrad, “Integrating mobile, web and sensory technologies to support inquiry-based science learning,” in *Proceedings of the 2010 6th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education*, pp. 65–72, IEEE, Kaohsiung, Taiwan, April 2010.
- [21] M. Jain, J. Birnholtz, E. Cutrell, and R. Balakrishnan, “Exploring display techniques for mobile collaborative learning in developing regions,” in *Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services*, pp. 81–90, Stockholm, Sweden, August 2011.
- [22] E. Klopfer, *Augmented Learning: Research and Design of Mobile Educational Games*, MIT Press, Cambridge, MA, USA, 2008.
- [23] J. C. Reis, R. Bonacin, and M. C. Martins, “Developing informal education through mobilecollaborative learning,” in *Proceedings of the 12th IASTED International Conference on Computers and Advanced Technology in Education (CATE’09)*, pp. 1–7, Charlotte Amalie, VI, USA, November 2009.
- [24] Y. Park, “A pedagogical framework for mobile learning: categorizing educational applications of mobile technologies into four types,” *International Review of Research in Open and Distance Learning*, vol. 12, no. 2, pp. 78–102, 2011.
- [25] M. L. Bernacki, J. A. Greene, and H. Crompton, “Mobile technology, learning, and achievement: advances in understanding and measuring the role of mobile technology in education,” *Contemporary Educational Psychology*, vol. 60, Article ID 101827, 2020.
- [26] C. Rapanta, L. Botturi, P. Goodyear, L. Guàrdia, and M. Koole, “Online university teaching during and after the Covid-19 crisis: refocusing teacher presence and learning activity,” *Postdigital Science and Education*, vol. 2, no. 3, pp. 923–945, 2020.
- [27] M. R. Breines and M. Gallagher, “A return to teacherbot: rethinking the development of educational technology at the university of Edinburgh,” *Teaching in Higher Education*, pp. 1–15, 2020.
- [28] T. Murphy, “Conversations on engaged pedagogies, independent thinking skills and active citizenship,” *Issues in Educational Research*, vol. 20, no. 1, pp. 39–46, 2010.
- [29] S. Sarkar, “The role of information and communication technology (ICT) in higher education for the 21st century,” *Science*, vol. 1, no. 1, pp. 30–41, 2012.
- [30] H. Boholano, “Smart social networking: 21st century teaching and learning skills,” *Research in Pedagogy*, vol. 7, no. 2, pp. 21–29, 2017.
- [31] N. Ramakrishnan and J. J. Priya, “Effectiveness of flipped classroom in mathematics teaching,” *International Journal of Regulation and Governance*, vol. 4, no. 10(SE), pp. 57–62, 2016.
- [32] G. J. Hwang, C. L. Lai, and S. Y. Wang, “Seamless flipped learning: a mobile technology-enhanced flipped classroom with effective learning strategies,” *Journal of Computers in Education*, vol. 2, no. 4, pp. 449–473, 2015.
- [33] B. F. Klimova, “Developing thinking skills in the course of academic writing,” *Procedia-Social and Behavioral Sciences*, vol. 93, pp. 508–511, 2013.
- [34] F. Ghaemi and S. J. G. Mirsaeed, “The impact of inquiry-based learning approach on critical thinking skill of EFL students,” *EFL Journal*, vol. 2, no. 2, pp. 89–102, 2017.

- [35] N. Alagozlu, "Critical thinking and voice in EFL writing," *Asian EFL Journal*, vol. 9, no. 3, pp. 118–136, 2007.
- [36] G. Melles, "Teaching and evaluation of critical appraisal skills to postgraduate ESL engineering students," *Innovations in Education & Teaching International*, vol. 46, no. 2, pp. 161–170, 2009.
- [37] R. Wette, "Evaluating student learning in a university-level EAP unit on writing using sources," *Journal of Second Language Writing*, vol. 19, no. 3, pp. 158–177, 2010.
- [38] R. Paul and L. Elder, *A Guide for Educators to Critical Thinking Competency Standards: Standards, Principles, Performance Indicators, and Outcomes with a Critical Thinking Master Rubric*, Rowman & Littlefield, Lanham, ML, USA, 2019.
- [39] D. R. Ferris and J. Hedgcock, *Teaching L2 Composition: Purpose, Process, and Practice*, Routledge, Oxford, UK, 2013.
- [40] P. H. Yen, "The impact of PPP and TBLT on Vietnamese students' writing performance and self-regulation," Doctoral Dissertation, KU Leuven University, Leuven, Belgium, 2014.
- [41] D. Desta, "Observations and reflections of the higher education teachers on the quality of teaching and learning in higher education in Ethiopia," *The Ethiopian Journal of Higher Education*, vol. 1, no. 1, pp. 63–81, 2004.
- [42] C. M. Chou, T. C. Shen, T. C. Shen, and C. H. Shen, "Influencing factors on students' learning effectiveness of AI-based technology application: mediation variable of the human-computer interaction experience," *Education and Information Technologies*, vol. 27, no. 6, pp. 8723–8750, 2022.
- [43] X. Fan and X. Zhong, "Artificial intelligence-based creative thinking skill analysis model using human-computer interaction in art design teaching," *Computers & Electrical Engineering*, vol. 100, Article ID 107957, 2022.
- [44] Y. Liu, C. B. Sivaparthipan, and A. Shankar, "Human-computer interaction based visual feedback system for augmentative and alternative communication," *International Journal of Speech Technology*, vol. 25, no. 2, pp. 305–314, 2022.
- [45] N. Thakur and B. D. Parameshachari, *Human-Computer Interaction and beyond: Advances towards Smart and Interconnected Environments (Part II)*, Bentham Science Publishers, Sharjah, UAE, 2022.
- [46] S. Baller, S. Dutta, and B. Lanvin, *Global Information Technology Report 2016*, Ouranos, Geneva, Switzerland, 2016.
- [47] J. McClure and J. Pilgrim, "Implementing a 1:1 technology program in a rural, public school: a study of perceptions of technology integration," *Journal of Research on Technology in Education*, vol. 54, no. 2, pp. 302–316, 2022.
- [48] A. Collins and R. Halverson, *Rethinking Education in the Age of Technology: The Digital Revolution and Schooling in America*, Teachers College Press, New York, NY, United States, 2018.
- [49] Y. H. S. Al-Mamary, "Examining the factors affecting the use of ICT in teaching in Yemeni schools," *Journal of Public Affairs*, vol. 22, no. 1, Article ID e2330, 2022.
- [50] R. Zhang and D. Zou, "Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning," *Computer Assisted Language Learning*, vol. 35, no. 4, pp. 696–742, 2022.
- [51] A. Bailin, "AI and language learning: theory and evaluations," in *Intelligent Language Tutors*, pp. 345–362, Routledge, Oxford, UK, 2014.
- [52] J. C. Liang, G. J. Hwang, M. R. A. Chen, and D. Darmawansah, "Roles and research foci of artificial intelligence in language education: an integrated bibliographic analysis and systematic review approach," *Interactive Learning Environments*, vol. 30, no. 8, pp. 1–27, 2021.
- [53] A. Kukulska-Hulme and L. Shield, "An overview of mobile assisted language learning: from content delivery to supported collaboration and interaction," *ReCALL*, vol. 20, no. 3, pp. 271–289, 2008.
- [54] G. Conole, M. De Laat, T. Dillon, and J. Darby, "'Disruptive technologies,' 'pedagogical innovation': what's new? findings from an in-depth study of students' use and perception of technology," *Computers & Education*, vol. 50, no. 2, pp. 511–524, 2008.
- [55] R. Haupin, *Improving Receptive Oral Language Skills of English Language Learners to Enhance Achievement in Reading Recovery*, Widener University, Chester, PA, USA, Doctor of Education, 2016.
- [56] S. Heeke, H. Delingette, Y. Fanjat et al., "The age of artificial intelligence in lung cancer pathology: between hope, gloom and perspectives," *Annales de Pathologie*, vol. 39, no. 2, pp. 130–136, 2019.
- [57] I. Roll and R. Wylie, "Evolution and revolution in artificial intelligence in education," *International Journal of Artificial Intelligence in Education*, vol. 26, no. 2, pp. 582–599, 2016.
- [58] N. J. Car, "USING decision models to enable better irrigation decision support systems," *Computers and Electronics in Agriculture*, vol. 152, pp. 290–301, 2018.
- [59] F. Kong, "Application of artificial intelligence in modern art teaching," *International Journal of Emerging Technologies in Learning (IJET)*, vol. 15, no. 13, pp. 238–251, 2020.
- [60] F. L. De Mello and S. A. de Souza, "Psychotherapy and artificial intelligence: a proposal for alignment," *Frontiers in Psychology*, vol. 10, p. 263, 2019.
- [61] S. Canagarajah, *The Routledge Handbook of Migration and Language*, Taylor & Francis, Oxford, UK, 2017.
- [62] M. R. Hawkins and J. Mori, "Considering 'trans-' perspectives in language theories and practices," *Applied Linguistics*, vol. 39, no. 1, pp. 1–8, 2018.
- [63] E. Ribeiro, R. Ribeiro, and D. M. de Matos, "A multilingual and multidomain study on dialog act recognition using character-level tokenization," *Information*, vol. 10, no. 3, p. 94, 2019.
- [64] C. Barnes-Hawkins, "English language learners' perspectives of the communicative language approach," Walden University, Minneapolis, MN, USA, Doctor of Education, 2016.
- [65] Z. M. Radwan, *Artificial Intelligence and its Impact on Development*, ASBAR Council, Riyadh, Saudi Arabia, 2017.
- [66] S. K. W. Chu, R. B. Reynolds, N. J. Tavares, M. Notari, and C. W. Y. Lee, *21st Century Skills Development through Inquiry-Based Learning from Theory to Practice*, Springer International Publishing, Berlin, Germany, 2021.
- [67] L. Li, "Integrating thinking skills in foreign language learning: what can we learn from teachers' perspectives?" *Thinking Skills and Creativity*, vol. 22, pp. 273–288, 2016.
- [68] O. Lee, H. Quinn, and G. Valdés, "Science and language for English language learners in relation to next generation science standards and with implications for common core state standards for English language arts and mathematics," *Educational Researcher*, vol. 42, no. 4, pp. 223–233, 2013.
- [69] R. Yuan, W. Liao, Z. Wang, J. Kong, and Y. Zhang, "How do English-as-a-foreign-language (EFL) teachers perceive and engage with critical thinking: a systematic review from 2010 to 2020," *Thinking Skills and Creativity*, vol. 43, Article ID 101002, 2022.
- [70] Y. Prado, S. Jacob, and M. Warschauer, "Teaching computational thinking to exceptional learners: lessons from two



- inclusive classrooms,” *Computer Science Education*, vol. 32, no. 2, pp. 188–212, 2022.
- [71] M. R. Hashemi and A. Ghanizadeh, “Critical discourse analysis and critical thinking: an experimental study in an EFL context,” *System*, vol. 40, no. 1, pp. 37–47, 2012.
- [72] M. E. Nejad, S. Izadpanah, E. Namaziandost, and B. Rahbar, “The mediating role of critical thinking abilities in the relationship between English as a foreign language learners’ writing performance and their language learning strategies,” *Frontiers in Psychology*, vol. 13, Article ID 746445, 2022.
- [73] D. Lu and Y. N. Xie, “Critical thinking cultivation in TESOL with ICT tools: a systematic review,” *Computer Assisted Language Learning*, vol. 35, no. 8, pp. 1–21, 2022.
- [74] X. Du and L. Zhang, “Investigating EFL learners’ perceptions of critical thinking learning affordances: voices from Chinese university English majors,” *Sage Open*, vol. 12, no. 2, Article ID 215824402210945, 2022.
- [75] Z. Hongwei, “Developing critical thinking skills in Russian language studies: online learning tools in Chinese universities,” *Foreign Language Annals*, vol. 55, no. 1, pp. 98–115, 2022.
- [76] J. W. Creswell, *A Concise Introduction to Mixed Methods Research*, SAGE publications, Thousand Oaks, CA, USA, 2014.
- [77] T. May and B. Perry, *Social Research: Issues, Methods and Process*, McGraw-Hill Education, London, UK, 2022.
- [78] E. DePoy and L. N. Gitlin, *Introduction to Research E-Book: Understanding and Applying Multiple Strategies*, Elsevier Health Sciences, Amsterdam, Netherlands, 2019.
- [79] C. R. Kothari, *Research Methodology: Methods and Techniques Second Revised Edition*, New Age International Publishers, New Delhi, India, 2004.
- [80] W. L. Neuman, *Social Research Methods: Qualitative and Quantitative Approaches*, Pearson Education, London, UK, 2013.
- [81] B. Miri, B. C. David, and Z. Uri, “Purposely teaching for the promotion of higher-order thinking skills: a case of critical thinking,” *Research in Science Education*, vol. 37, no. 4, pp. 353–369, 2007.
- [82] Y. Bin and D. Mandal, “English teaching practice based on artificial intelligence technology,” *Journal of Intelligent and Fuzzy Systems*, vol. 37, no. 3, pp. 3381–3391, 2019.
- [83] Z. Sun, M. Anbarasan, and D. Praveen Kumar, “Design of online intelligent English teaching platform based on artificial intelligence techniques,” *Computational Intelligence*, vol. 37, no. 3, pp. 1166–1180, 2021.
- [84] S. Zou, “Designing and practice of a college English teaching platform based on artificial intelligence,” *Journal of Computational and Theoretical Nanoscience*, vol. 14, no. 1, pp. 104–108, 2017.
- [85] M. Riel, “Educational change in a technology-rich environment,” *Journal of Research on Computing in Education*, vol. 26, no. 4, pp. 452–474, 2014.