



Human Elements in Pedagogical Assistants that Aid in English Language Teaching & Learning: An Offline Study

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Abstract

Technological development continuously advances with additional innovations added to the existing account. Yesterday's apps, today's ChatGPT, and tomorrow's extended reality applications are proof of continuous innovation in the Information Technology (IT) sector. During the 2020 pandemic, the world's education system shifted to online teaching. By then, Artificial Intelligence (AI) had already invested in introducing pedagogical agents (PAs) in teaching through multimedia learning. There are multiple attributable studies about human-comparable on-screen agents that support teaching and improve learning performance with their human characteristics like bodily moments, spoken narration, emotional expression, and gestures. Besides, AI provided pedagogical agents with an exuberant quality of surveilling students during classes. Foreign or second language teachers typically observe emotionality in the classrooms to motivate, encourage, and provide feedback. Thus, the current study aims to investigate and compare the characteristic features of pedagogical agents with those of on-screen teachers. It will explore to what extent the features stimulate the learning process in English as a Foreign Language (EFL) / English as a second language (ESL) learning. Additionally, the present study attempts to cover the classification of emotionality and agents' contextual appearance in teaching English classes. The study will compare the pedagogical agents' characteristics with human screen teachers' characteristics using one-tailed, right-tailed F-test variance. The study proves that pedagogical agents are considered equal partners with on-screen teachers based on the available characteristics. Additionally, the study signals the need for future teachers to acquire technical skills.

Keywords: EFL/ESL, emotionality, instruction and feedback, language learning, pedagogical agents

1 Introduction

Technology has always been a driving force behind innovations and developmental achievements, but this has accelerated since the COVID-19 pandemic hit. Today, new AI-

based, VR-related open applications have entered educational technology. The pedagogical agent is one such innovation with 20 years of research behind it. It goes by various names, such as anthropological agents (AA), controlled agents (CA), or virtual agents (VA). Virtual agents are like people with the will to pursue their goals and plans. Virtual agents are humanlike characters in instructional software that motivate learners by facilitating learning and supporting them socially and emotionally (Reategui et al., 2007). Most design principles of pedagogical agents include the transversality of empathic abilities, the promotion of dialogic learning, proficiency in knowledge, and personalized feedback according to the student's level (Ortega-Ochoa et al., 2023). These pedagogical agents play an essential role in teaching and learning and their embodiment and emotional features make them fit to provide instruction in the teaching field. The pedagogical agents come in different persona sizes, such as mono-element agents with voice, eyes, or deictic gestures, and multi-element agents. In the present scenario, pedagogical agents have multiple anthropological features and are highly competitive with subject-specific instruction and feedback like human pedagogues.

The effective use of virtual agents in language learning remains unexplored (Johnson & Lester, 2018). Intelligent personal assistants can help L2 learners improve their language skills by practicing speaking, listening, and repetition. They also can encourage learners to improve their language skills by helping them reformulate and self-correct their mistakes and practice language speaking skills (Moussalli & Cardoso, 2020) in non-native learners, as they have limited opportunities to master the English language (Lan et al., 2020). Given the crucial role of the English language in international communication, further research is necessary to investigate the characteristics of pedagogical agents in English language learning. Although technology in language education is still relatively new Gu et al., (2023), VR technology has recently been widely used (Liu et al., 2023). At this point, it is essential to recall that these agents can strengthen learner autonomy and improve learning performance with their humanistic features. Therefore, this study focuses on agents' characteristics and their effectiveness, as well as their participation in teaching and learning English. The study focuses on the elements that aid teaching and the specific skills learned.

2 Literature Review

Pedagogical agents' primary and most important characteristic feature is their ability to gesture. Their body moments include sliding, swapping, jumping, appearing, disappearing, making gestures and actions, remaining silent. They can communicate by text, speech, movement, voice, writing, and video. There are four different types of gestures that pedagogical agents use, which are classified based on their explicit function.

1. Specific pointing gestures, e.g., points to a specific part of a diagram
2. General pointing gestures, e.g., points to a common direction
3. Non-pointing gestures, e.g., do not point
4. No gestures

Among these four gestural features, it has been found that specific pointing gestures retained more subject knowledge in learners. In transfer tests, learners who used specific pointing gestures outperformed. When measuring the transfer of instructional domains, gesture agents had a larger impact in domains like science and math than in humanities, with no agent or static conditions (Davis et al., 2019). Limited embodiment agents can help recall declarative knowledge through internet searches when agents use eye gaze and body movements without facial expressions and gestures (Fountoukidou et al., 2019). Specific pointing gestures are effective in multimedia learning and align with embodiment and image principles (Bmk et al., 2019). People use different types of gestures during nonverbal communication, including

iconic (concrete information, e.g., mirror), metamorphic (abstract information, e.g., memory), deictic (representing information, e.g., pointing), and beat (non-representing information, e.g., moments). Using suitable gestures can significantly improve learning effectiveness and positively affect achieving learning outcomes. Appropriate gestures in foreign language vocabulary learning enhance comprehension and memory performance (der Putten & Bergmann, 2020). The more suitable gestures used, the better the comprehension.

Virtual reality offers learners opportunities to interact with meaningful contexts and increases motivation and learner engagement, resulting in active learning and creativity (Chen, 2016). Agents should have social perception skills to interact with peers and comprehend texts (Kim, 2013). Gestural imitation is an effective way to learn nouns, while images aid in learning verbs (der Putten & Bergmann, 2020). Various gestures create rich face-to-face deep learning interactions that aid in retaining knowledge and enhance the virtual agent's identity (Davis et al., 2019). However, the agent persona is independent of the number of gestures and strength of social cues. High embodiment of virtual agents and their nonverbal social cues increase agent perception and transfer of learning. For instance, in retention and grammar transfer tests, Korean 5th and 6th grade students are engaged by full-body and human-like gestures than deictic, non-gesture, and no-agent types. The significant role of teachable agents is to make the learners self-regulated by supporting their learning and increasing learner involvement (Baranwal, 2022). Voice chatbots help learners gain autonomy by providing personalized learning with quick feedback, which allows learners to correct their pronunciation and intonation (Lee & Lim, 2023). The agents can improve grammar learning as peers and increase learners' speaking proficiency. Positive pedagogical agents well-motivate learners to create positive emotions and facilitate learning performance (Wang et al., 2023).

The ability of pedagogical agents to express emotions is a second important characteristic feature. Emotions are categorized based on the expressions of pedagogical agents (van Kuilenburg et al., 2005). Based on muscular movements, the facial action coding system (FACS) classified the facial expressions as happy, sad, disgusted, joyful, angry, fearful, and surprised. The observation of emotions reveals a positive correlation between learner engagement and confusion, while boredom has a negative correlation. Other emotions do not correlate with learner engagement (Hayashi, 2019). Negative emotions on learners' faces can lead to mutual understanding conversations. When learners are confused, pedagogical agents provide cognitive support in an intelligent tutoring system (Long et al., 2019). The positivity principle suggests that learners learn better from instructors who exhibit positive emotions than those with negative emotions (Lawson et al., 2021). In his study with animated agents, Lawson et al. (2021) identified that students can recognize two important behaviors of agents. The emotions considered in the experiment are happy (positive and active), content (positive and passive), bored (negative and active), and frustrated (negative and passive). Students can recognize positive and negative emotions better than active and passive emotions. Learners can also recognize the active emotions of humans more quickly than animated agents. A study narrated animation of pedagogical agents as happy, neutral, and calm. Happy PAs with smiling expressions and enthusiastic voices and neutral PAs with neutral expressions and calm voices were subsequently tested for emotions, motivation, and cognitive outcomes. The results support the cognitive-affective learning theory with media because students are happier and more motivated by happy PAs than neutral PAs.

This paragraph focuses on the impact of gender, error correction, and feedback characteristics effectiveness of pedagogical agents. The gender effect in a study indicates that the male participants rated VECA as an effective agent, whereas female participants rated nonvisible

VECAs as an effective agent in learning (Scholten et al., 2019). The humor and fear appeal of three-dimensional animated pedagogical agents positively influenced learning, regardless of their appeal (Buttussi & Chittaro, 2020). Ceha et al. (2021) demonstrate that affiliative humor can significantly increase motivation and effort, while self-defeating humor, although enhancing effort, negatively impacts enjoyment. An animated learning video with appropriate clothing of agents in an inappropriate setting discloses that learners acquire knowledge (Decker & Merkt, 2023). Due to the small effect size of the interaction, designers of animated agent videos have some degree of freedom. Nevertheless, depending on the level of appropriateness, the degree of freedom may be limited. An experiment with a set of male and female agents with neutral and enthusiastic expressions reveals that the agent's enthusiasm is directly proportional to positive perceptions of the learner and inversely proportional to transfer performance (Beege & Schneider, 2023). In this scenario, the knowledge retention rate is higher in males regardless of the pedagogical agent's gender. In contrast, the rate is higher only with the enthusiastic expressions of the female agent but not the male agent. Experiments with pedagogical agents for their feedback with and without emotion result in elaborate knowledge (Lang et al., 2022). Though emotional and elaborate feedback has no connection, emotional feedback activates intrinsic motivation to reduce learner confusion, which results in enhanced learner perception, and elaborated feedback increases intrinsic motivation, agent perception, and transfer performance. Lang et al. (2022) study advocates the need to fulfill the feedback with emotional and cognitive needs. Depending on their design principle, pedagogical agents provide feedback and correct errors. IPA (intelligent pedagogical agents) offer instant help when students need help learning. Agents help without distraction and provide help once per error or once more for the same error. IPAs have two versions of interventions: one-shot intervention and repeated intervention. The former corrects one error once, and the latter corrects the same error repeatedly (Yalcin et al., 2023). The feedback or praise from the mentor agent affects the learners' performance and perceptions and contributes to better learning outcomes (Ortega-Ochoa et al., 2023).

Agent-delivered modeling effectively serves self-efficacy beliefs, system-specific ease, increased declarative knowledge, and task performance outcomes (Fountoukidou et al., 2019). Pedagogical agents guide and support learners to perform tasks without impetus, affective support, and learning experience (Scholten et al., 2019). However, appearance and voice have meaningful effects, while animation does not have any effect. Eyelink 1000 Plus is an eye-tracker that checks learners' visual attendance using the interface and pedagogical agents with text with their eye moments (Wei & Chow, 2021). In the same way, eye tracking in virtual learning assesses the students' eye moments with an interface and agents, supporting the enhancement of learning and reduction of cognitive load. The agents' gestures are meaningful and positively influence the learning performance (Wei, 2024). Dialogue agents provide highly personalized support to learners in expressing their preferences through their willingness to communicate (WTC) (Hayashi, 2023). Hayashi identified in his experiment that some gaze parameters are interrelated with recalling memory. Highly embodied pedagogical agents with eye fixation, eye contact, and pointing gestures on the pertinent graphic result in better learning transfer, consequently increasing test scores, though there is no impact using eye gaze direction (Li et al., 2015). In the multimedia environment, the pedagogical effects of pedagogical agents increased intrinsic motivation (Wang et al., 2023). There was no significant difference in learning performance, motivation, and self-regulation except more self-efficacy with the agent when two groups of online students were taught by a DSLab-bot, an empathetic chatbot, and an onscreen teacher, respectively. The specific feedback types used in the experiment were effective and facilitated learning (Ortega-Ochoa et al., 2024).

Media equation theory emphasizes the best suitability of the positivity principle for animated instructors (Reeves & Nass, 1996). In Lawson *et al.* (2021) experiment, students rated the positive agent as a better facilitator agent with more engagement among happy, content, frustrated, and bored agents because they could pay more attention during positive agent teaching. In contrast, they also revealed that they could have performed better on delayed tests. Happy and content agents have positive emotions, while frustrated and bored agents have negative emotions. Furthermore, the happy agent is active, the content agent is passive, the frustrated agent is active, and the bored agent is passive. Learners describe voice-controlled conversational agents as human-like conversational partners in their drawings and interviews, as VCA is a potential interactive partner in learning English (Lee & Jeon, 2022). The themes identified in voice agents during teaching pronunciation are human, artifact, and residual forms because the English pronunciation sub-skill is clear but lacks emotion. The convenience and pervasive role of voice-controlled conversational agents influence EFL students' teaching and learning. As per Social agency theory, when learning with pedagogical agents, learners can make partnerships and engage entirely in information processing and meaning-making so that deep learning occurs. Due to their voice, language, and human-like features, pedagogical agents are social agents (Atkinson *et al.*, 2005). Virtual agents focus on the social perception of peers and comprehension of texts (Kim, 2013). Teaching using pedagogical agents increases motivation, attention, learning satisfaction, confidence, memory, imagery, and concreteness (Carlotto & Jaques, 2016). With the help of virtual agents, learners can control their emotions (Graesser *et al.*, 2017). The study by Graesser *et al.*, (2017) and Davis & Vincent (2019). showcased how the phonological developments of pedagogical agents help learners improve their social perceptual skills and academic performance. der Putten & Bergmann (2020) state that the wide use of technology provides near-realistic learning scenarios. He also states that second language-related research using pedagogical agents has become more common in some areas that positively impact learning second-language vocabulary and declarative knowledge of a foreign language (Davis *et al.*, 2021). Voice-activated agents interacting with teachable agents benefit the level of language proficiency (Gonulal, 2021) and improve English listening skills (Davis *et al.*, 2021). The practice of subject-specific virtual agents increased the use of artificial intelligence, and the research of language learning using virtual avatars continues to increase with existing literature. Intelligent pedagogical agents are valuable tools in language classrooms as they help learners learn micro concepts of L2 phonology, such as past tense marking, perceptual listening, language acquisition and production, and morpho-phonemics of the language (Moussalli & Cardoso, 2021). Learners could achieve expected learning outcomes better when learning with a positive pedagogical agent than with a neutral pedagogical agent, and in between these two pedagogical agents, positive pedagogical agents paid more attention through visual processing. Supervising and evaluating artificial intelligence is necessary, and institutes should develop critical thinking skills among learners to better use generative AI (Williamson, 2024). The literature highlights the benefits of pedagogical agents in English language education specifically, on (der Putten & Bergmann, 2020), nouns and verbs (Gu *et al.*, 2023), pronouns (Lin *et al.*, 2020), sentences (Savvani & Liapis, 2019), dialogue (Baranwal, 2022), grammar (McDonough & Sato, 2019), speaking (Paetzel *et al.*, 2020) and (Lee & Lim, 2023), past tense, allomorphs, and pronunciation (Moussalli & Cardoso, 2021), reading comprehension (Li *et al.*, 2015), reading instruction (Jensen & Willbergh, 2023) and writing (Gao & Passonneau, 2021).

3 Methodology

3.1 Theoretical applications

A good learning theory is insightful and informative for teaching practice (Ellis, 2010). The relationship between theory and practice can be reciprocal and cyclic from theory to practice or practice to theory (Lantolf et al., 2014). At once, teachable agents are human-like conversational partners with human elements and voices. A strong tendency toward anthropomorphism has excellent potential in EFL contexts. The development of anthropomorphism in interaction is related to intersubjectivity, imagination, and theory of mind (Airenti, 2018). Social agency theory suggests social cues such as human language and visuals develop partnerships with virtual tutors and, thus, engage in information processing and meaning-making with a deeper understanding of subject-related instructional material. The media equation theory is the first theory that declares the role of virtual agents, which applies human social rules to multimedia and treats media agents as real people. Media equation theory gives virtual agents equal status to humans by applying human social rules. This theory treats virtual agents as real people because of similar features such as embodiment, body moments, facial emotions, gestures, and mimicking. Epley et al.'s (2007) three-factor theory of anthropomorphism includes knowledge, effect, and sociality; effect and sociality endorse the degree of human representation and promote anthropomorphic features vigorously in EFL students in L1 settings (Lee & Jeon, 2022). Current literature demonstrates that modern computer voice can successfully facilitate social perceptions.

3.2 F-test

The F-test determines whether the differences between the two independent groups are homogenous. The null and alternate hypotheses are determined as follows.

Null hypothesis=the variances are equal, i.e.1

Alternative hypothesis=the variances are not equal i.e. $>1/<1$

Degrees of freedom (df) = $n-1$

Enter the variances of two groups into MS Excel to calculate the F statistic using the following formula ($F \text{ statistic} = S1^2 / S2^2$) for two variances by squaring the deviations to get variances. Then, divide the most significant value as a numerator with the slight variance as the denominator for the f-value because it is a one-tailed, right-tailed test. The one-tailed test moves in one direction with greater or lesser first sample values when compared to the second sample values and in the right-tailed test, the large variance population will be the numerator. The other way of calculating is by using the data analysis pack of Excel to calculate the f-value and critical f-value. Then, see the correct level f-table to see whether the null hypothesis is accepted or rejected. We can confidently reject the null hypothesis when the f-table value is smaller than the calculated f-value.

In this research, the value of a degree is 1 for each change in a feature. For example, the body movements score is 12 for agents based on the available movements such as sliding, swapping, jumping, appearing, disappearing, making gestures, actions, mimicking, remaining silent, waving movements, writing text, and body (video) speed. Given these movements, the score of an on-screen teacher is 6. The following table illustrates the scores for the nine features of two samples.

Table 1: Varying features of embodiment and moments in PA vs. OT (onscreen teachers)

Sl.N o.	Embodiment OT		PA	Body moments PA OT		
2.	half body	✓	x	body positioning	✓	✓
3.	only eyes	✓	x	swapping	✓	x
4.	only hand	✓	x	writing text	✓	✓
5.	stylized	✓	✓	bump, popup	✓	x
6.	only voice	✓	x	video speed	✓	x
7.	cartoon-like	✓	x	Sliding	✓	x
8.	ethnic consistency	✓	✓	jumping	✓	✓
				Action	✓	✓
				Appearing	✓	x
				disappearing	✓	x
				Mimicking	✓	✓
				remaining silent	✓	✓

Sample 1 = on-screen teacher

Sample 2 = pedagogical agent

Table 2 Features and values

Feature	Samples	Scores
Embodiment	1	1
Speech	1	7
Emotions	1	8
Body moments	1	6
Gender	1	2
Gestures	1	6
Eyes	1	8
Facial expressions	1	3
Persona Size	1	2
Embodiment	2	8
Speech	2	7
Emotions	2	8
Body moments	2	12
Gender	2	2
Gestures	2	6
Eyes	2	8
Facial expressions	2	5
Persona Size	2	2

Degrees of freedom (df) = $n-9$

so, $df = 9-1 = 8$

Table 3: Table of F value

F-Test Two-Sample for Variances		
	<i>Sample 1</i>	<i>Sample 2</i>
Mean	4.777778	6.444444
Variance	7.694444	10.02778
Observations	9	9
Df	8	8
F	0.767313	
P(F<=f) one-tail	0.358466	
F Critical one-tail	0.290858	

We can reject the null hypothesis since the F value exceeds the F critical one tail value ($0.767 > 0.290$). Therefore, the variances of the two groups' samples are unequal, or the F table value, 2.5894, is less than the F-calculated value, 0.7673.

3.3 Discussion

Primarily, COVID-19 has brought significant changes in education, and currently, AI (artificial intelligence) and AR (augmented reality) are playing pivotal roles in education. The innovation of pedagogical agents is a technological development tool that aids teaching. It is a common conception that human-like features can substitute human teachers online to some extent, as well as what environment they create and how they enhance learning performance. However, which type of knowledge (Davis & Vincent, 2019) and to which level of students the agents can teach is still unclear. The development of automated agents is to overcome the challenge of complex language comprehension and dialogue organization of the provided corpus (Paetzel et al., 2020). Such agents help study discourse phenomena like turn-taking, filling pauses, and using discourse markers, reference, and co-reference resolutions. Hence, the future envisions AI and virtual pedagogue technology to assist non-native speakers in language learning. The study by (Bmk, 2019). emphasizes the essential need for AI agents. The pedagogical agents are incomparable to humans as they possess the profound potential to guide and support learning (Scholten et al., 2019).

In communication, pedagogical agents are outside the line with humans, so such actions may lead to a fall in the efficiency and serviceability of the learning process. Ergo, it is essential to develop communication with a multidisciplinary and theoretical approach to ensure that all aspects of communication are covered and understood thoroughly (Sikstrom et al., 2022). Further attention on exploring the abilities of these agents can help technology support learners.

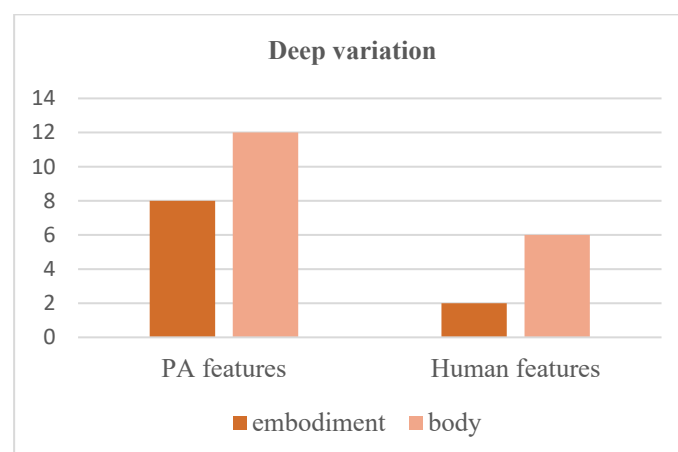
The f-statistic value helps analyze the data variance of the two samples. The variances of the samples are unequal because the test rejected the null hypothesis. As mentioned prior, there is no relationship between the two population groups. The Sample 1 population is meant for on-screen human teachers, and Sample 2 is meant for pedagogical agents. The F value supports the alternate hypothesis and confirms that the variances are unequal. Sample 1 variance value is 7.69, and sample 2 variance value is 10.02, which shows that pedagogical agents are much different from on-screen teachers. Pedagogical agents are human-like because they are designed to resemble human beings but are not the same as actual human beings. They are not precisely equal partners to the teaching community. However, their services to the

learning community are sometimes more characteristic of body movements, gestures, and forms of embodiment in providing motivation and engagement. Some movements, like jumping or disappearance, cannot be demonstrated even by on-screen teachers. However, the designers can make some properties possible with on-screen teachers, such as appearance and disappearance. However, the pedagogical agents have primordial to critical features that help teaching and learning communities; the next step for teachers is to use them as per the availability and necessity.

Pedagogical agents incorporate artificial intelligence techniques to analyze and indicate their actions. Ortega-Ochoa et al. (2024) mention them as artificial intelligence of things. They belong to educational communities, specific to the teaching community, so their design needs the involvement of the techno-savvy (Lantolf et al., 2014) and teachers to better tailor the technology according to the needs and evaluation of the classrooms. Many English teachers lack the knowledge to work with developing technology because of the internalization of augmented reality in various English learning contexts like learning material, environment, and gaming (Saforrudin et al., 2011). It is essential to take the necessary steps to ensure educators have enough knowledge to handle the technology. Teacher-student interaction with technology became more frequent after the pandemic, yet innovations encourage language teachers to include more technology in their EFL classrooms. Instructors must update their technical skills to prepare good quality teaching and learning material to match the chosen teaching methods. It is not archaic for language teachers to shape themselves to be on par with technological innovations for the future.

Based on their similarity, the features compared in the study can be categorized into three sections. The first section constitutes a group of features similar to pedagogical agents and onscreen teachers, e.g., Gender, gestures, eyes, and persona. The second set of features has more similarities alongside a few variations, e.g., Speech, emotional expressions, and facial expressions. The last third set of groups consists of many variations between them. e.g., embodiment, body moments. Graph 1 illustrates the variation in features of pedagogical agents and onscreen teachers.

Figure 1: Variating features of embodiment and moments in PA vs. OT (onscreen teachers)



3.4 Limitations

The comparative study is based on sample features available in pedagogical agents, ignoring the features available in the population. To identify subtle differences, the degree of variance

in pedagogical agents' features is determined based on the availability of features in recent research studies from the Web of Science.

4 Conclusion

The development of pedagogical agents takes multiple forms, such as whole, half, multiple-organ, or single-organ forms like dialogue, image, or agent with required emotion to reach the heights of technology by increasing agents' potential. A well-designed three-dimensional and subject-specific pedagogical agent design and building process is expensive. The recent advancements are trying to integrate extended reality and pedagogical agents to serve the field of learning more. Undoubtedly, these human-controlled pedagogical agents are a new generation of tools in the educational field. The use and research of pedagogical agents are growing continuously in science-related fields, whereas in English learning, research is still lacking. In English, speaking should include essential elements like pronunciation, intonation, accuracy, appropriateness, flow, and clarity. Pedagogical agents are worth teaching English speaking skills as all the elements above are quintessentially available in the native-like speech of pedagogical agents. Additionally, the agents provide immediate, empathetic feedback, and it appears to be a peer rather than a teacher. Most of the research on teaching English relates to English language acquisition and practicing skills. In contrast, it is essential to extend research efforts to include literature and theoretical linguistics. After everything, human potential is deep, thoughtful, creative, and proactive, requiring no switch for initiation and activation. Therefore, it can be harnessed for unlimited innovations that pedagogical agents cannot inspire.

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