Anthromorphizing Virtual Robot Tutor (VTR) on Developing Computing Intelligence as Automating Teaching Process in EFL Sustainability

Muthmainnah Muthmainnah[1], Ahmed J. Obaid[2], Luis Cardoso[3], Ali Said Al Matari[4], Ken Paul M. Espinosa[5], Ahmad Al Yakin[1] and Eka Apriani[6]
[1]*Teacher Training and Education Faculty, Universitas Al Asyariah Mandar, Budi Utomo Str. 2, 91311 Polewali Mandar, Indonesia*
[2]*Faculty of Computer Science and Mathematics, University of Kufa, 54001 Najaf, Iraq*
[3]*Centre for Comparative Studies, Polytechnic University of Portalegre, Praça da República Str. 23-25, 7300-108 Portalegre, Portugal*
[4]*Mathematics Instructor, Center for Languages and Foundational Studies, A'Sharqiyah University, Sultan Turki bin Said Str. 400, 400 Ibra, Oman*
[5]*School of Graduate Studies, Baliuag University, Gil Carlos Str. 1069, 3006 Baliwag City, Philippines*
[6]*English Tadris Study Program, Faculty of Tarbiyah, IAIN Curup, Dr. Ak Gani Str. 1, 39119 Curup, Indonesia*
muthmainnahunasman@gmail.com, ahmedj.aljanaby@uokufa.edu.iq, lmcardoso@ipportalegre.pt, ali.almatari@asu.edu.om, kenpaulespinosa@baliuagu.edu.ph, ahmadalyakin76@gmail.com, eka.apriani@iaincurup.ac.id

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Abstract: This paper examined the influence of an anthropomorphic VRT on students' computational intelligence and English language skills in a technology-based learning environment. Pre-post study involving 68 subjects revealing significant changes in the scores: The mean pre-test being 47.53 (SD = 2.60) and post-test score of 86.82 (SD = 3.58); instrument reliability was noted at Cronbach's $\alpha = 0.839$. ANOVA showed a between-group effect ($F(13,54) = 8.513, p < .001$) with a high amount of between-group variance ($\eta^2 \approx 0.67$), whereas t-tests revealed accurate mean estimates at both measurement occasions. The interpretation of the findings provided evidence that VRT led to robust and consistent learning gains in the computational domain due to three core mechanisms: 1) adaptive scaffolding which diminished cognitive load as the range of solving strategies increased; 2) anthropomorphic social support, leading to greater motivation and propensity to engage with characters during learning activities; and 3) deliberative practice cycles which included immediate feedback with an adaptive task generator. Furthermore, by incorporating language-aware scaffolding, such as cohesion correction, rubric creation or reflective prompts in English into the framework we can ensure that computational competencies transfer to the learning of languages with learners' development both disciplinarily and linguistically being mutually supportive. In this study, anthropomorphic VRT shown some promise as a pedagogical practice for scaling up high quality teaching practices in the era of AIIoT, especially towards fostering computational intelligence and second language proficiency.

1 INTRODUCTION

The context of continuous learning demands personalization [1], scalability, independence, and flexibility. In reality, EFL learning remains confined to conventional teaching, which can stress and fatigue students, resulting in suboptimal language acquisition. The tendency for language learning to focus solely on text models and grammar is not aligned with the needs of the 21st century and digital literacy. Therefore, to meet these needs, EFL learning, while simultaneously developing computing skills, is designed with an anthropomorphic approach to foster an interactive, responsive, mindful, and meaningful classroom atmosphere [2].

The transformation of education with the advent of AI technology has the power to revolutionize traditional learning systems, transforming the way students and teachers learn. Automation of learning processes and learning facilities is becoming increasingly practical with the paradigm of AI as a virtual assistant [3].

Robotic education, supported by AIEd, creates a more personalized learning process, meaningful interactions, enjoyable learning experiences, and the comfort of learning can be felt in the classroom [4].

The role of AI agents as virtual robot tutors in instruction-oriented EFL learning, active learning automation, can be used anytime and anywhere without the constraints of space and time, thereby enhancing proactive learning independence. VTR feedback, flexible communication, and freedom to express language performance are believed to enhance second language acquisition. A Virtual Robot Tutor (VTR) is an EFL learning environment that uses virtual chatbots like Lola Speak or Tutor Eva with interactive video features that communicate with models as learning partners or tutors according to the student's needs.

According to [5] VTRs can transform into robot agents that participate in learning activities and meaningful interactions that can improve students' cognitive, affective, and psychomotor skills.

This research examining VTR as an anthropomorphic agent, functioning as an automation agent for foreign language acquisition training, is still rare. Therefore, this study is important because it offers a contribution in designing a VTR-based language learning model as an automation agent in the classroom that helps teachers adapt materials, exercises, and feedback. Furthermore, it also contributes to the development of computing intelligence as a sustainable future skill for EFL students through a learning ecosystem designed to be efficient, inclusive, relevant, adaptive, and scalable in the AI era.

2 LITERATURE REVIEW

Anthropomorphism is the assignment of human characteristics or humanization of AI (as if it were a real entity) by providing responses that tend to resemble human responses in a particular style [6]. The use of Video to Speech (VTR) in EFL classes creates interactions that foster emotional engagement, motivation, involvement, active learning, and high responsiveness.

The VTR design, based on the assumption that learning with an intelligent tutorial system (ITS) is the foundation of this study. The machine learning scenario is a practical and efficient learning alternative tailored to needs within an inclusive environment. The learning tendencies of Gen Alpha students, which are contextualized with representations of reality and real-world contexts (practicing language with native models), can be met with the features offered by VTR, which provide emotional comfort in learning [7].

Students can express themselves without intervention or judgment, practice without fear of error, improve their accuracy according to their individual learning styles, and reflect and repeat, creating meaningful language acquisition experiences. Students' computational skills also improve, as they learn to overcome their EFL language challenges, develop problem-solving skills, critical thinking skills, algorithmic learning, data-driven learning, and interact with machines. This undoubtedly impacts digital literacy for the continuation of valid education compared to traditional classrooms [8].

VTR utilizes guidance such as feedback and tutoring, reinforcing independent learning without a human teacher, and reducing mental fatigue. Natural language processing (NLP) in EFL learning evaluates students' level of foreign language acquisition productivity through repeated feedback, in-depth interaction, adaptive guidance, active response, and metalinguistics, which positively impact language learning.

3 METHODOLOGY

The research method of this study is quantitative using a pre-experimental approach without a control class with a pre- and post-test design. For the test, the pre-test, direct post-test, and post-test are the quantitative instruments of this study; while observation is a component used during the intervention in the classroom. This study only contains one independent variable (communication instructions) and only one dependent variable (communication test scores). In the treatment stage, the EFL language class uses an intelligent tutoring system (ITS) with a robot tutor Monica AI. This learning strategy is used to help students improve their computing intelligence and communication skills with the steps described in Table 1.

Table 1: VTR Anthropomorphizing in EFL.

Antromorphism Concept	Example AI Tools	EFL sustainability leaning step	Role of VTR	Computing Intelligence
Social engagement and motivation	LLM.based tutor (Monica AI, Voice, TTS and animated avatar (example Tutor Eva)	1. Greetings 2. Diagnostic mini-test	Build emotional connection via humanlike voice, facial cues, empathy, praise	Digital interaction literacy, social reasoning in AI-mediated context.
Automated teaching-adaptive feedback	NLP, grammar checker, automated scoring, speech feedback (ASR)	Speaking, writing, automated feedback and revision cycle	Provides instant personalized feedback, models correct output and gives micro scaffolding	Error detection, iterative refinement, feedback-loop thinking
Sustainability topic-meaningful communication	Knowledge-based agent, content recommender, retrieval-augmented generation	Reading/lietsening sustainability input, discussion and reflection	Facilitates purposeful dialogue, prompt critical and ethical responses	System thinking; argumentation and data-informed reasoning
Personalized pathway-learning efficiency	Learner analytics and recommender system	Need analysis, adaptive practice and progress visualization	Select tasks based on learner gaps, monitors progress and provided motivation	Pattern recognition; decision-making based on learning data
Problem based EFL task-algorithmic thinking	Interactive simulation, prompt-based reasoning tasks	Sustainability problem scenario; collaborative solution talk and presentation	Guides structured steps; define breakdown, propose, evaluate solutions	Decomposition, abstraction; algorithmic reasoning
Assessment automation- self regulation	Auto-quiz generator, automated rubrics, reflective journaling prompts	Micro quizzez, reflection log and goal setting	Evaluates learning outcomes, instantly and encourages metacognitive reflection	Metacognitive computing; self-regulation and autonomous learning

3.1 Participants

The study population consisted of 432 undergraduate students. The sample size was 68 students in the Faculty of Computer Science, majoring in Informatics Engineering. Students had laptops and smartphones used in class during the intervention, had never been exposed to AI, had no experience using Monica AI, and did not yet understand how to use VTR for EFL skills. The average age of respondents was 18-23 years, and they were enrolled in English courses in the first semester of the 2025 academic year.

3.2 Instrument

This research instrument was used to measure students' English language proficiency. We provided a communication test consisting of a dialogue script or short script. Students were then asked to practice communication skills and complete the test. During the test, students were asked to answer questions verbally, demonstrate speaking skills, and demonstrate collaborative communication projects on their respective YouTube accounts.

The virtual robot tutor (VTR) device used during the intervention was Monica AI (https://monica.im/). The intervention took place in class for 45 minutes, observing anthropomorphizing behavior and interactions throughout the learning process.

3.3 Data Analysis

In the data analysis stage, this study used SPSS software (version 26). We used a One-Sample t-test to check whether the scores were normally distributed. ANOVA comparison test was run to determine whether there were significant differences between the pre-test and post-test measurements.

4 RESULTS AND DISCUSSION

The following research results are presented in Table 2, which describe the results of the pre-test and post-test of the EFL language class using Monica AI's VTR.

Based on Table 2, the pre-test results showed an average score of 47.53, categorized as poor, and an average post-test score of 86.82, categorized as good. Overall, the data demonstrate descriptive statistics that the presence of VRT in EFL classes significantly improved student learning outcomes as shown in Table 3.

The reliability test results for both instruments showed an alpha of 0.839 or higher, and Cronbach's.

Table 2: Pre-post test of VTR.

	N	Min	Max	Mean	SD
Pretest	68	40.00	50.00	47.5294	2.60006
Posttest	68	76.00	95.00	86.8235	3.57830
Valid N (listwise)	68				

Table 3: Reliability statistic.

Cronbach's Alpha	N of Items
0.839	2

Alpha indicated high internal consistency (>0.80). This is a strength of the test, and the data demonstrates that both items are valid/reliable measures of the same concept.

Table 4: ANOVA analysis of selected variables.

ANOVA Metric	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	304.405	13	23.416	8.513	.000
Within Groups	148.536	54	2.751		
Total	452.941	67			

The one-way ANOVA results, as shown in Table 4, showed differences among the mean scores (df between = 13). Analysis of variance showed the data were highly significant ($F = 8.513$, $p < 0.001$). A significant main effect of group ($p = 0.001$) indicated that group means differed significantly in the multi-group comparison.

On Table 5 the data shown One sample t-test with a null hypothesis of 0 showed that the data before recalculation were: $t(67) = 150.742$, $p < 0.001$; mean difference = 47.53 (95% CI: 46.9001 - 48.1588). In the posttest, the statistical analysis also yielded significance ($t(67) = 200.085$, $p < 0.001$), with a mean difference of 86.82 (95% CI: 85.9574- 87.6897) indicating that the difference between the two groups was highly significant from a statistical point of view, so it can be assumed that pairwise comparisons would show substantial improvement. A narrow confidence interval that easily excludes 0 indicates that the mean estimate is accurate.

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Figure 1 shows that participants' mean posttest scores covered a much wider range (mid-70s to mid-90s), as illustrated in the figure, compared to their moderate initial pretest scores (which generally hovered around the 40s). This provides further evidence that the VTR intervention in the EFL classroom had a valid impact on students' competencies.

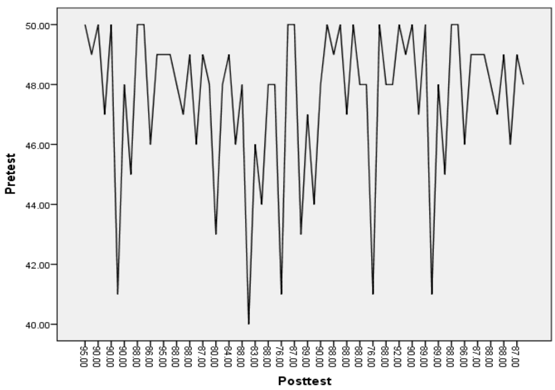

Figure 1: Sequence plot.

Table 5: One-sample test.

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Pretest	150.742	67	.000	47.52941	46.9001	48.1588
Posttest	200.085	67	.000	86.82353	85.9574	87.6897

The results of this study also provide strong evidence supporting the proposition that VRT can enable students to develop their computational intelligence and English language skills. Data from descriptive and inferential statistical tests indicate that the VRT intervention had a strong systematic effect that could not be attributed to measurement artifacts or sampling idiosyncrasies. This is confirmed by high internal consistency (Cronbach's $\alpha \approx 0.84$), a highly significant ANOVA ($F(13,54)=8.51$, $p < 0.001$; $\eta^2 \approx 0.67$), and a relatively homogeneous pre-test distribution ($M \approx 47.5$, $SD \approx 2.6$) as well as a highly skewed post-test distribution ($M \approx 86.8$, $SD \approx 3.6$).

The results of this study indicate that the AI intervention with VRT features demonstrated statistically significant improvements in grades but also demonstrated pedagogically significant changes [9].

Three related processes can best explain this pattern. First, adaptive scaffolding was implemented, namely: (1) VRT can diagnose students' current computational strategies and offer personalized scaffolding (e.g., step-by-step instructions; formative mini-tasks; increasingly difficult problems) that directly engage effective tutoring principles (zone of proximal development scaffolding; feedback). This was intended to reduce cognitive load on novices while gradually developing their problem-solving skills in a clear and coherent manner, which is expected to provide long-term benefits comparable to meta-analytic findings on AI tutors [10]; (2) social benefits of anthropomorphism: because VRT provided pedagogical information through a socially salient (human-like) interface (voice, turn-taking, examples), it may have increased affective practice variables such as motivation and persistence that mediate practice time and conceptual fidelity [11] and [12] showed that embodied social cues increase engagement and attention, which are crucial priors to learning, in social robots; (3) Data-driven feedback, on mindful practice: VRT's adaptive problem generation and automated scoring create a fast-paced practice environment with a tight feedback cycle for course correction (it is this combination of feedback and practice that is truly necessary for adaptive systems to function according to research similar to the findings of this study by [13] Importantly, the intervention resulted in measurable improvements in English language proficiency.

Driven by the intentional language-sensitive framework within VRT, children experienced structured production and comprehension practice over time to achieve this dual effect. This framework consisted of contextualized problem prompts in English, direct corrective feedback of domain-relevant vocabulary, and generative prompts that encouraged explanation and reflection in English. Computational learning, not learned in isolation from use but guided by purposeful English use, paved the way for the transition from domain practice to language skills.

Similar research by [14] and [15] corroborates the findings of this study, stating that intelligent tutors and social robots in content need to be integrated into communicative tasks and then coupled with language objectives, thereby improving the content acquisition process and addressing language competency deficits. As in AI-enhanced language learning, where adaptive feedback can not only aid the development of language proficiency but also concurrently the learning of content [16] the potential of VRT to simulate meta-strategies (think-aloud prompts and planning templates) supports the emergence of metacognitive registers manifested in English as well [17].

These findings also offer three theoretical and practical implications. These findings potentially minimize the need for one-on-one human tutoring while retaining the essential features of high-quality instruction, including the adaptability, pace, and social motivational support that make it so successful.

This intervention supports the view that computational intelligence (e.g., problem decomposition, debugging approaches, and procedural fluency) is optimally developed through prolonged, socially mediated, adaptive practice in an English-speaking communicative environment. Integrating computer skill development with SLA in this way, demonstrating innovative EFL learning independent of transfer tasks, would further enhance this particular study design, however impressive its effect size and reliability.

Furthermore, future studies might benefit from evaluating equivalence, including considering whether students from different linguistic backgrounds benefit equally and elucidating which anthropomorphic components (voice, persona, affective presentation) exert the strongest motivational effects.

Finally, this work aligns with a growing body of literature demonstrating that appropriately designed AI tutors and social robots can produce substantial learning gains in both domain- and language-related tasks. Exemplary studies include [17]. tutoring efficacy in teaching context Arab [18]. meta analysis review, [19] review of social robots in educational settings and robots for learning communication [20] meta-analysis of intelligent tutoring systems, and individual factsheet reports of improved programming, computing, or language outcomes with the assistance of robots or AI when adaptive feedback and social presence are included. Thanks to these efforts, there is a strong theoretical and empirical foundation for scaling VRT as a complementary tool to help advance continuous, bilingual, and computationally rich learning that supports 21st-century learning systems.

4 CONCLUSIONS

The findings of the present article suggest that an anthropomorphized VRT is viable and effective as a pedagogical intervention to enhance computer intelligence learning progress and simultaneously bolster English language proficiency in 21st-century EFL based on the skills perspective. From a practical point of view, VRT is acting as teaching capacity multiplier: it enables scalability on an unprecedented scale via adaptation, offload the work of content creation from teacher and keep students motivated and engaged in the learning process due to social support they can offer.

The results highlight the relevance of integrating computational problem-solving tasks with linguistic scaffolding allowing disciplinary and language learning to go along together, thus offering more authentic and workplace-oriented competences. Policy support is needed for large-scale implementation, including infrastructure investments, sensible programs to train teachers and standards-based evaluation of the efficacy of intelligent learning technology.

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