Interactive Robots for Accessibility in Diverse Classrooms: A Case of Cantonese Learning for NAS and NCS

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Abstract

Multicultural education in Hong Kong poses learning challenges. For example, non-Chinese-speaking (NCS) students and newly-arrived students (NAS) come from diverse linguistic backgrounds. However, existing interventions emphasise unidirectional instruction. This study addresses the gap by investigating how an interactive robot-assisted scenario *(RAS)* system can support Cantonese instruction in multicultural classrooms. We employ a mixed-method approach examining quantitative engagement measures and qualitative experiential data. We investigate how *RAS* intervention can influence the engagement and motivation of NAS and NCS students to learn Cantonese, and the impacts of *RAS* on the Cantonese proficiency outcomes of NAS and NCS learners. Findings reveal differential engagement patterns: NAS demonstrate improvements in behavioural engagement, while NCS students show a slight decline in cognitive engagement. This research contributes to human-agent interaction (HAI) by examining cross-cultural learning dynamics and providing preliminary insights for the development of multicultural educational technologies.

CCS Concepts

• **Applied computing** → **Interactive learning environments**; **Computer-assisted instruction**; • **Human-centered computing** → *Empirical studies in HCI*.

Keywords

Interactive Learning, Robot-assisted Language Learning (RALL), Scenario-based Learning, Self-determination Theory, Motivation

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1 Introduction

Background. The Hong Kong education system is multicultural. Students are required to speak Cantonese and write Traditional Chinese, as it is their mother tongue. A classroom typically consists of local, non-Chinese-speaking (NCS) students and newly-arrived students (NAS) from Mandarin-speaking backgrounds. Students from different cultural backgrounds may encounter various difficulties. For NAS, the transition from Mandarin to Cantonese presents substantial linguistic obstacles due to the complexity of tones [18]. Although NAS can recognise most Traditional Chinese characters, some characters still differ between the Simplified and Traditional Chinese systems [6]. NCS students may face additional challenges when transitioning from alphabetic to logographic writing systems. They may learn Traditional Chinese characters without direct phonetic guidance [21]. If they cannot overcome the difficulties, the disadvantages may hinder academic performance, peer communication, and social integration [1, 9].

Empowering Interactive Learning Technology for Robots in Education. Educational robots can provide student-centred learning experiences through interactive robotic learning systems. This learning model primarily utilises interactive robots to enhance motivation to learn and skill acquisition through bidirectional interaction [4]. A study showed that effective learning outcomes can be strengthened through technologies and interactivity [3]. The interactive learning approach encourages student participation, moving away from passive to active learning [10]. This approach can support diverse learning and foster knowledge retention [13].

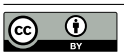
Motivation and Engagement in Education. Self-determination theory (SDT) emphasises that human motivation flourishes when three psychological needs (i.e., autonomy, competence, and relatedness) are met [15]. SDT has been widely applied in educational technology and language learning to facilitate learning engagement and performance [5]. SDT principles inform the design and evaluation of digital systems that promote motivation [14].

Real-Life Scenarios in Language Learning. Real-life scenarios in language learning are grounded in the principles of communicative language teaching (CLT) [2], which emphasises the importance of using language in authentic scenarios to magnify communicative competence and cultural understanding [17]. Language acquisition is effective when tied to practical situations rather than abstract drills [20]. Educators can build students' communication skills by anchoring classroom activities in authentic situations.

2 System Design

We designed an interactive robot-assisted scenario *(RAS)* system that incorporates real-world contexts on an interactive robot, *Boon Boon* [12]. *Boon Boon* is equipped with a head featuring a 9-inch high-definition screen and four wheels.

The scenarios and interfaces were co-designed by two professionals specialising in language learning and human-agent interaction (HAI). The contexts were collaboratively designed by education experts and reviewed by two experienced teachers. It contains three contexts. **Set 1: Supermarket** was designed to promote the proper



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use of shopping carts and baskets and to instruct students on how to conduct themselves while shopping. **Set 2: Restaurant** was designed to instruct students on the proper actions and manners to observe in a dining setting. **Set 3: Transportation** was designed to teach students railway-related knowledge and appropriate behavioural standards in public transportation.

Interface Design. The UI is developed according to the specifications, ensuring consistency and accessibility in real-world contexts. This approach assures design uniformity and a high level of colour contrast, ultimately enhancing accessibility and readability.

***RAS* Design.** *RAS* was developed in Unity (c#) and integrated automatic speech recognition (ASR), supporting both Speech-to-Text (STT) and Text-to-Speech (TTS) function. *RAS* supported to converse spoken language into text, transcription and translation in Cantonese. *RAS* provided real-life responses by comparing student input with the pre-programmed content with a four-step process, including engagement, cognition, assessment, and reinforcement.

3 Experiment

Participants included 10 NAS (M = 8.33 years, SD = 0.83) and 10 NCS (M = 8.20 years, SD = 0.88) aged 6 to 10 from a local primary school. Students who participated in the study had the following criteria: learning in grades 1 to 3, learning Traditional Chinese and speaking Cantonese for at least one year, being a NAS or NCS student, having no physical impairments that could interfere with their interaction with robots or cognitive performance, and having experience in utilising digital devices, such as tablets. Prior to the study, informed consent was obtained from the students and their guardians. Participation was fully voluntary. The University Institutional Review Board (IRB) approved the experimental protocol.

Triangulations. To comprehensively assess learning interests, we used a triangulation approach: questionnaires, observations, interviews, and proficiency tests. Two special and inclusive education raters analysed participant feedback during the observation and interview phases. The pre- and post-questionnaires consisted of four variables categorised as motivation and engagement. The questionnaires were used in the same region [7], and we modified them for our study. An experienced teacher reviewed the items to ensure the clarity of the questionnaire. Surveys included pre- and post-participation engagement and motivation assessments, comprising the following: *Behavioural Engagement (BE)*, (e.g., I try my best to finish all activities), *Emotional Engagement (EE)*, (e.g., I pay attention when I learn with the robot), *Cognitive Engagement (CE)* and (e.g., I check my work to make sure it is right), *Intrinsic Motivation (IM)* (e.g., I feel happy when I am learning).

4 Data Analysis

RQ1: How does interactive RAS learning influence the engagement and motivation of NAS and NCS students in learning Cantonese within a multicultural classroom? The findings of a single-sampled paired t-test indicated that learning with interactive robots can improve students' BE, EE, and IM. **NAS** improved BE by 13.56%, $p < .05$ (pre: M = 78.67, SD = 14.33; post: M = 89.33, SD = 8.43). They improved EE by 4.76%, $p = .05$ (pre: M = 84.00, SD = 11.42; post: M = 88.00, SD = 8.78). They improved CE by 3.25%, $p = .46$ (pre: M = 82.00, SD = 12.59; post: M = 84.67, SD = 11.78). They improved IM by 0.74%, $p = .76$ (pre: M = 90.00, SD = 11.00; post: M = 90.67, SD = 10.98). From the descriptive statistics above, NAS demonstrated improvement in three areas of engagement and motivation after a four-day learning period. The increase in BE was particularly significant. **NCS** students improved BE by 1.79%, $p = .74$ (pre: M = 74.67, SD = 8.20; post: M = 76.00, SD = 12.25). They improved EE by 5.31%, $p = .53$ (pre: M = 75.33, SD = 16.94; post: M = 79.33, SD = 13.86). They decreased CE by 4.27%, $p = .63$ (pre: M = 78.00, SD = 16.04; post: M = 74.67, SD = 19.06). They improved IM by 3.33%, $p = .53$ (pre: M = 80.00, SD = 9.94; post: M = 82.67, SD = 13.77). From the descriptive statistics above, NCS students showed improvement in BE, EE, and IM after a four-day learning period, while CE decreased.

RQ2: What is the impact of the *RAS* on the Cantonese language proficiency of NAS and NCS? The results showed that the score of NAS improved by 5.66%, $p = .74$, $f = .11$ (pre: M = 63.10, SD = 30.79; post: M = 66.67, SD = 26.15). The score of the NCS students improved by 20.59%, $p = .38$, $f = .83$ (pre: M = 56.67, SD = 29.61; post: M = 68.33, SD = 27.72).

5 Discussion

Learning Engagement. Students' positive engagement is influenced by immediate feedback and reciprocal responses. The findings indicate that *RAS* can enhance learning motivation, particularly NAS. Active feedback serves as a reinforcer of positive reinforcement, encouraging students to engage in the learning process and further promoting language acquisition [8, 11].

Motivation. *RAS* helps students build confidence. They often feel shy in traditional classroom, which hinders their active participation. *Boon Boon*'s friendly design can reduce students' anxiety and create a welcoming atmosphere, encouraging them to speak up. As noted by [19], a supportive environment is crucial for attracting students' attention and reducing feelings of apprehension. The supportive features of *RAS* can support their intrinsic motivation.

Language Proficiency. Context-driven learning courses can enhance students' comprehension skills. In this study, after four days of *RAS* learning, students' Cantonese proficiency improved by 5.66% and 20.59%, respectively. Scenario-based learning can make vocabulary learning more understandable to students, allowing them to better visualise the new language [16].

Limitations. This preliminary study is primarily limited by its small sample size. As a result, most observed differences were not statistically significant. These findings should be interpreted with caution, as they may reflect an underpowered sample rather than a true absence of effect. Future research employing larger cohorts is required to establish more robust conclusions.

6 Conclusion

This work showed that RALL increased NAS enthusiasm for active learning. The short-term study has found some design opportunities for RALL to improve NAS academic success. *RAS* can impact to the community on a larger scale and for broader beneficiary groups (e.g., dyslexia, autism, and older adults) in other languages.

References

[1] Surayyo Abidjanova. 2024. Highlighting How Lack of Preparation in Academic English Impacts Student Success in Global University Contexts. *Talqin va tadqiqotlar ilmiy-uslubiy jurnali* 2, 56 (2024), 94–98.

[2] Habtamu Adem and Mendida Berkessa. 2022. A case study of EFL teachers' practice of teaching speaking skills vis-à-vis the principles of Communicative Language Teaching (CLT). *Cogent Education* 9, 1 (2022), 2087458.

[3] Muneeb Ahmad and Abdullah Alzahrani. 2023. Crucial clues: Investigating psychophysiological behaviors for measuring trust in human-robot interaction. In *Proceedings of the 25th International Conference on Multimodal Interaction*. 135–143.

[4] Vetha Vikashini Chithrra Raghuram et al. 2022. Personalized productive engagement recognition in robot-mediated collaborative learning. In *Proceedings of the 2022 international conference on multimodal interaction*. 632–641.

[5] Thomas KF Chiu. 2023. Student engagement in K-12 online learning amid COVID-19: A qualitative approach from a self-determination theory perspective. *Interactive learning environments* 31, 6 (2023), 3326–3339.

[6] Ka-Yan Fung et al. 2022. Can students with dyslexia learn independently? A seven-week study of Chinese character learning in an informal learning environment. *IEEE Transactions on Learning Technologies* 16, 5 (2022), 619–632.

[7] Ka Yan Fung et al. 2024. Humanoid robot-empowered language learning based on self-determination theory. *Education and Information Technologies* 29, 14 (2024), 18927–18957.

[8] Ka Yan Fung and Kuen Fung Sin. 2026. Loving Baby: An AI-Supported Robotic Companion for Primary Education–Early Evidence on Emotions, Engagement and Well-Being. In *Proceedings of the 2026 ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies*. 73–76.

[9] Wills Kalisha. 2025. Embracing the Language Barrier: Ignoring Misunderstandings in Teaching Language to Newly Arrived Unaccompanied Minors Seeking Asylum in Norway. In *Educating the Next Generation: Reflections on Crises, Migration, and Education*. Springer, 161–176.

[10] Farrukh Kamran et al. 2023. Impact of interactive teaching methods on students learning outcomes at university level. *Journal of Positive School Psychology* 7, 7 (2023), 89–105.

[11] Shuai Ma et al. 2023. Modeling adaptive expression of robot learning engagement and exploring its effects on human teachers. *ACM Transactions on Computer-Human Interaction* 30, 5 (2023), 1–48.

[12] NA. 2025. *Minibo Plus*. https://intelligentdesign.hk/english/robot/

[13] David Pérez-López and Manuel Contero. 2013. Delivering educational multimedia contents through an augmented reality application: A case study on its impact on knowledge acquisition and retention. *Turkish Online Journal of Educational Technology-TOJET* 12, 4 (2013), 19–28.

[14] Dorian Peters et al. 2018. Designing for motivation, engagement and wellbeing in digital experience. *Frontiers in psychology* 9 (2018), 300159.

[15] Richard M Ryan and Edward L Deci. 2024. Self-determination theory. In *Encyclopedia of quality of life and well-being research*. Springer, 6229–6235.

[16] Fan Su and Di Zou. 2022. Technology-enhanced collaborative language learning: theoretical foundations, technologies, and implications. *Computer Assisted Language Learning* 35, 8 (2022), 1754–1788.

[17] Febri Dhany Triwibowo. 2023. Enhancing English proficiency: The impact of communicative language teaching on second language learners. *Tomorrow's Education Journal* 1, 2 (2023).

[18] Isabella Valentini. 2014. Cantonese and Putonghua in Hong Kong: Trends, challenges, and perspectives of coexistence. (2014).

[19] Wen-Chi Vivian Wu et al. 2015. Instructional design using an in-house built teaching assistant robot to enhance elementary school English-as-a-foreign-language learning. *Interactive Learning Environments* 23, 6 (2015), 696–714.

[20] Lu Ye. 2024. Innovative pedagogical strategies in second language acquisition. In *SHS Web of Conferences*, Vol. 183. EDP Sciences, 03013.

[21] Kehui Zhang, Xin Sun, Chi-Lin Yu, Rachel L Eggleston, Rebecca A Marks, Nia Nickerson, Valeria C Caruso, Xiao-Su Hu, Twila Tardif, Tai-Li Chou, et al. 2023. Phonological and morphological literacy skills in English and Chinese: a cross-linguistic neuroimaging comparison of Chinese–English bilingual and monolingual English children. *Human brain mapping* 44, 13 (2023), 4812–4829.