TRACK 1: PHYSICS

Transforming ChatGPT for human-like interaction in Physics Education: A case study using content and language integrated learning with GCE A/L students

H. L. W. P. Guruge[1], M. S. Gunawardene[2], R. V. Coorey[2]

[1]*Sacred Heart Convent, Galle, Sri Lanka*

[2]*Department of Physics, Faculty of Science, University of Colombo, Sri Lanka*

This study investigates the transformative potential of ChatGPT when reconfigured to support human-like interaction in physics education. Moving beyond its conventional use for providing direct answers, ChatGPT was adapted to engage students in reflective, question-driven dialogue, encouraging metacognitive development and conceptual understanding. The intervention focused on 32 female GCE A/L physics students and was grounded in student-centered learning, Vygotsky's Zone of Proximal Development, and principles of Content and Language Integrated Learning (CLIL). Students worked in collaborative groups and participated in hands-on experiments involving oscillatory motion in springs and pendulums. These experiences formed the basis for AI-guided discussions where students refined mathematical models of simple harmonic motion. Digital tools such as PhET simulations, GeoGebra, Desmos, and Data Lab enhanced visual reasoning and supported conceptual exploration. ChatGPT's instructional scaffolding was personalized and gradually reduced as students exhibited increased independence in problem-solving. The intervention progressed from experimental observations to modeling wave phenomena and the Doppler Effect. In the second phase, students' ability to construct and explain physical models independently was assessed. Pre- and post-tests using the Physics Inventory of Quantitative Literacy (PIQL) were administered, and a Wilcoxon Signed-Rank test indicated a statistically significant improvement in performance, with mean scores rising from 25% to 58% ($p < 0.001$). Gains were especially notable in proportional and co-variational reasoning and in interpreting signed quantities. Qualitative analysis of AI logs and peer discussions revealed a shift from vague or purely grammatical responses to semantically rich, scientifically accurate explanations. ChatGPT's affirming prompts fostered student confidence and encouraged the use of appropriate scientific vocabulary. Overall, the findings suggest that a humanized AI, when embedded in a constructivist, CLIL-based framework, can act as a scalable instructional partner. Such integration holds promise for enhancing learning in resource-limited and large-class environments by promoting deeper engagement, critical thinking, and autonomous learning in physics education.

Keywords: *AI in education, ChatGPT, Content and Language Integrated learning (CLIL), Constructivist learning, Vygotsky's zone of proximal development (ZPD)*