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Objective Evaluation Metrics from Behavioral Logs in Metaverse-Based International Virtual Exchange: Total Movement Distance and Learners' Self-Reported Intercultural Understanding

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Abstract: We propose an evaluation approach that uses behavioral logs as objective indicators in metaverse-based international virtual exchange (VE). Using VRChat logs, we computed total movement distance during presentations and examined its association with self-reported active participation and the deepening of intercultural understanding. In course presentation activities (N = 9 with valid survey responses), total movement distance showed moderate positive associations with both outcomes, suggesting that behavioral logs may be related to learning effects in metaverse classes.

Keywords: Metaverse, International Virtual Exchange, Behavioral Logs, Intercultural Understanding

1. Introduction

Intercultural understanding is a key goal of international education, and international virtual exchange (VE) provides opportunities for intercultural experiences even for students who cannot study abroad (Hackett et al., 2023; O'Dowd, 2021). In particular, VE conducted in XR/metaverse environments has been shown to promote active exploration and to enhance engagement and the deepening of intercultural understanding (Hayashi, 2024). Accordingly, metaverse-based international VE is likely to become increasingly important.

Learning outcomes are often assessed via self-reports, which are susceptible to bias. Although objective approaches, such as qualitative analyses of conversations, have been proposed (Gutiérrez-Santiuste, E, et al., 2023), they still depend on analysts' interpretations. In this study, we focus on behavioral logs obtainable in metaverse environments as quantitative, objective indicators. While prior work has analyzed logs to inform learning-environment design (Yano, K, et al., 2024), they have rarely been employed as objective measures to evaluate educational outcomes. This gap suggests the necessity of investigating whether behavioral logs can serve as valid indicators of learning outcomes.

Building on this, we adopt total distance traveled as an exploratory pilot metric for behavioral-log analysis in metaverse-based intercultural learning and examine its association with conventional self-reported measures of learning outcomes. Following Hayashi (Hayashi,M, 2024), we adopt two subjective measures; active participation as a facet of engagement, and deepening of intercultural understanding as a core learning outcome. Based on the above, we pose the following research questions

1.1 Research Questions (RQ)

In a metaverse-based international VE, how does an objective behavioral indicator—audience total distance traveled—relate to learners' subjective self-evaluations of learning?

- *RQ1.* What is the relationship between total distance traveled and perceived degree of active participation?
- *RQ2.* What is the relationship between total distance traveled and perceived deepening of intercultural understanding?

2. Methods

The course was conducted in a hybrid format combining on-campus and remote (overseas partner) participation (comprising of 15 sessions: Sessions 1–10 = preparation; Sessions 11–15 = presentations). We used VRChat (VRChat, 2025) as the metaverse platform, and each student group created and presented a VR world on the theme of intercultural understanding. The analysis focused on behavioral logs from the presentation phase, excluding the low-mobility preparation sessions; remote students were excluded due to differing participation modes. We obtained valid questionnaire responses from nine on-campus participants (5 Japanese, 4 international). Each presentation lasted 15 minutes. After the course concluded, we administered a self-report questionnaire using a five-point Likert scale. The questionnaire assessed the degree of active participation (the extent to which students actively engaged in the class) and the deepening of intercultural understanding (whether their knowledge increased, their thinking deepened, and discussion was facilitated). The study received institutional ethics approval and informed consent from all participants, and personally identifying information (e.g., real names, usernames) was anonymized using substitute IDs.

We partially extended the YAIBA (YAIBA, 2025) logging tool to capture each student's world coordinates (x, y, z). The sampling interval was set to 5 seconds, the shortest interval that ensured stable operation. Participants provided permission for behavioral-log collection. To protect privacy, only the principal investigator was authorized to export logs, and students were prevented from viewing their own or others' behavioral histories. The collected behavioral logs were analyzed using scripts written in Python 3.11.

3. Results

The results obtained are presented in Figure 1. The self-report measures analyzed in this study were twofold: active participation and the deepening of intercultural understanding (knowledge gains, cognitive elaboration, and facilitation of discussion).

Using Pearson's correlation, we evaluated associations between total movement distance and each self-reported measure. For RQ1, total movement distance showed a moderate positive correlation with active participation ($r = 0.632$). For RQ2, a similar pattern held across all items assessing the deepening of intercultural understanding; total movement distance exhibited a moderate positive correlation with this outcome ($r = 0.495$).

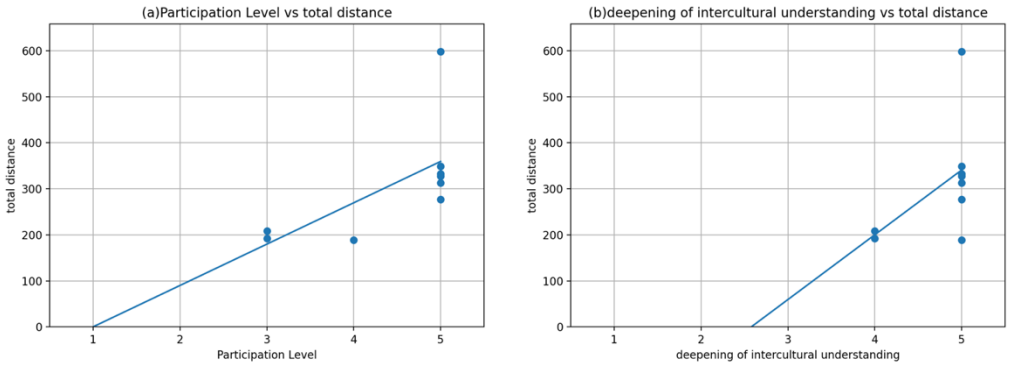

Figure 1. total distance vs. (a) participation level, (b) deepening of intercultural understanding.

4. Discussion

These findings suggest that the amount of movement within the metaverse may be associated with learners' subjective learning experiences and their level of class participation. Notably, in an authentic classroom setting with diverse course designs and student characteristics, a single, simple metric, total movement distance, showed directionally consistent associations with multiple self-reported measures. This provides initial evidence that behavioral logs, as an objective indicator, may be related to metrics used to assess learning outcomes.

5. Conclusion and Future Works

This study examined the association between total movement distance in the metaverse and subjective learning outcomes. The results showed positive correlations between movement distance and learners' sense of active participation and depth of thinking, suggesting that behavioral logs, as an objective indicator, can contribute to the evaluation of learning outcomes.

At the same time, our behavioral measurement relied solely on total distance traveled. As such, it could not capture stationary but meaningful engagement, such as periods of immersion while examining content, moments of concentrated attention to a presenter's explanation, quiz-answering, or other learning activities that do not involve movement.

In future work, we will enrich the contextual information of behavioral data by detecting and recording, at finer granularity, head orientation and interaction events (e.g., object manipulation, button presses, quiz responses) in addition to movement distance.

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