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Evaluating an Immersive System for Parkinson’s Disease Empathy Training Using In-Situ Surveys and Gameplay Telemetry

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Abstract

Immersive information systems are increasingly used in education and training contexts, but evaluating learner response during use remains challenging. This paper presents an applied HCI evaluation of a Parkinson's disease virtual reality (VR) simulation designed for healthcare empathy training. The study analyzes two embedded data streams collected during classroom gameplay: doorway empathy surveys presented at three room-transition checkpoints and task-level performance logs across six activities of daily living. Data from 47 participants showed consistently positive empathy-related responses, with 89.4%, 76.6%, and 87.2% selecting strongly agree or agree at the three checkpoints, respectively. Gameplay logs showed meaningful variation in task difficulty: cereal preparation had the longest mean completion time, while pill interaction and cereal preparation produced the highest object-drop counts. Spearman correlations between doorway survey ratings and corresponding segment-level performance metrics were weak and non-significant. The study contributes a practical approach for combining in-situ self-report and gameplay telemetry to evaluate empathy-oriented VR experiences in healthcare education.

Keywords: virtual reality, empathy training, healthcare education, Parkinson's disease, serious games, in-game assessment

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1. INTRODUCTION

Empathy is an important component of patient-centered healthcare, particularly when caring for patients with chronic and degenerative conditions (Moudatsou et al., 2020; Derksen et al., 2013). However, it can be difficult for learners to understand how disease symptoms affect everyday life when instruction relies mainly on lectures, readings, or observation. Parkinson's disease is a meaningful case for experiential learning because symptoms such as tremor, slowed movement, and impaired fine motor control can make routine activities of daily living difficult, frustrating, and time-consuming (Kalia & Lang, 2015; Poewe et al., 2017; Foki et al., 2016).

Virtual reality (VR) offers a useful medium for perspective-taking because it can place learners in interactive, embodied, first-person experiences that are difficult to reproduce through traditional instruction (Dyer et al., 2018; Bertrand et al., 2018; Jiang et al., 2022). A prior version of the Parkinson's disease VR simulation allowed learners to complete daily living tasks in a home environment while experiencing tremor-based interaction difficulty (Li et al., 2021). The system was later deployed in an interprofessional healthcare education setting (Li et al., 2024), where students reported increased appreciation for how Parkinson's disease affects daily living and viewed VR as a useful tool for healthcare education.

Although these findings were encouraging, prior evaluation focused primarily on system design and post-experience perceptions. Less is known about how empathy-related responses emerge during the VR experience itself, or how such responses relate to behavioral measures collected during gameplay. This creates a need for embedded evaluation methods that can capture learner responses without substantially disrupting immersion.

To address this gap, the present study analyzes two forms of data collected during classroom use of the Parkinson's disease VR simulation. First, the system recorded task-level performance data across six activities of daily living, including time, score, and object drops. Second, the simulation presented short doorway surveys at three room-transition checkpoints, allowing participants to report empathy-related responses while still immersed in the routine. These checkpoints occurred after meaningful segments of the simulated day rather than only at the end of the experience.

This paper contributes an applied HCI evaluation of an immersive information system for healthcare education. Specifically, we examine: (1) how empathy-related responses vary across transition checkpoints, (2) how gameplay performance differs across daily living tasks, and (3) whether embedded empathy responses are associated with performance-based indicators of task difficulty.

2. RELATED WORK

2.1 Immersive Information Systems for Healthcare Education

Empathy is essential to patient-centered care, but it remains difficult to teach through conventional instructional methods alone. Lectures, readings, and case discussions can communicate symptoms and clinical facts, but they may not fully convey the lived frustration, limitations, and emotional burden associated with chronic conditions. VR offers a way to support perspective-taking by placing learners in immersive, first-person experiences where they can interact with simulated situations from a patient's viewpoint.

Prior studies have explored VR for empathy development in healthcare education, including applications related to aging, symptom experience, and patient-centered learning (Dyer et al., 2018;

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Bertrand et al., 2018; Jiang et al., 2022). For example, Dyer et al. (2018) described VR as a tool for empathy-oriented medical education, Bertrand et al. (2018) synthesized strategies for empathy development through embodied VR, and Jiang et al. (2022) reviewed broader uses of VR in medical student education. Together, this work suggests that VR can increase learner engagement and help students better appreciate patient challenges.

However, many evaluations of empathy-oriented VR rely primarily on pre-/post-questionnaires or post-session reflections. These methods are useful for assessing overall change or satisfaction, but they provide limited insight into how empathy-related responses emerge during the experience itself. As a result, less is known about how learners respond at specific moments within an immersive simulation, especially when task difficulty, narrative context, and embodiment interact during play.

2.2 HCI and Experiential Simulation for Parkinson's Disease

Parkinson's disease is a neurodegenerative condition that can affect movement, balance, and fine motor control (Kalia & Lang, 2015; Poewe et al., 2017). Symptoms such as tremor, slowed movement, rigidity, and reduced dexterity can make daily activities, including grooming, eating, medication management, and communication, more difficult. For healthcare learners, understanding these everyday barriers is important because it may support more patient-centered attitudes and more thoughtful care.

Activities of daily living provide a useful structure for Parkinson's disease simulation because they connect clinical symptoms to practical consequences (Kalia & Lang, 2015; Foki et al., 2016; Thorp et al., 2018). A learner may understand tremor as a symptom in the abstract, but the experience of attempting to hold an object, prepare food, select medication, or dial a phone under tremor-like conditions can reveal how symptoms affect independence and routine self-care. This makes daily living tasks appropriate for empathy-oriented VR design.

VR research related to Parkinson's disease has often focused on rehabilitation, balance training, or motor support for patients. In contrast, fewer systems use VR to help healthcare learners experience the patient's perspective. The present study addresses this gap by framing Parkinson's disease VR as a lived-experience simulation for empathy-oriented healthcare education. Rather than training patients to improve motor function, the simulation is designed to help learners reflect on how motor impairment can shape everyday experience.

2.3 Embedded Assessment and Gameplay Telemetry

A key challenge in VR learning research is how to collect meaningful learner response data without disrupting immersion. Many studies rely on questionnaires administered before or after the simulation, which may miss changes in response that occur during the experience. Embedded assessment offers an alternative by placing lightweight measures within the simulation at natural points in the activity.

For empathy-oriented VR, embedded assessment is especially useful because affective and reflective responses may shift as learners encounter frustration, task difficulty, or new contextual information. In the present study, doorway surveys are placed at room transitions in the simulated home routine. These transition points allow participants to report empathy-related responses while remaining in the experience, and they can be analyzed alongside gameplay logs to connect subjective responses with behavioral measures.

This approach also aligns with the design of task-based serious games, where learning analytics can be collected during gameplay without requiring a separate testing session. In-game performance measures such as time, score, and object drops provide behavioral evidence of task difficulty, while embedded self-report captures participants' immediate interpretation of the experience. Combining these two data sources can support a more process-oriented understanding of VR empathy training.

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3. SYSTEM AND STUDY DESIGN

3.1 VR Simulation and Task Flow

The Parkinson's disease VR simulation is a first-person, home-based experience designed to help learners understand how Parkinson's disease can interfere with routine activities of daily living. The system builds on previously reported Parkinson's disease VR simulation design and classroom implementation (Li et al., 2021, 2024). It was developed in Unity and uses task-based progression, narrative guidance, tremor-based hand instability, and interactive object manipulation to place participants in the role of a patient completing a morning routine.

The experience begins in the bedroom, where the participant turns off an alarm, then moves to the bathroom for showering and tooth brushing, proceeds to the kitchen for cereal preparation, food preparation, and medication selection, and finally returns to the bedroom to use a phone to call a doctor. This room-to-room structure supports a coherent lived-routine flow rather than a set of isolated tasks. Figure 1 provides an overview of the VR home environment, including the bedroom, bathroom, and kitchen areas used in the simulation. The numbered markers illustrate the task progression and embedded survey locations. The room sequence and embedded checkpoints are summarized in Table 1.

The primary symptom simulation focuses on hand tremor. During task interaction, the virtual hand motion is perturbed to create instability during reaching, grabbing, carrying, and precise placement. This design intentionally makes ordinary actions more difficult, such as holding utensils, placing objects, selecting pills, or pressing phone buttons. The goal is not to clinically reproduce every aspect of Parkinson's disease, but to create an experiential learning environment that helps participants recognize how motor symptoms can affect daily independence.

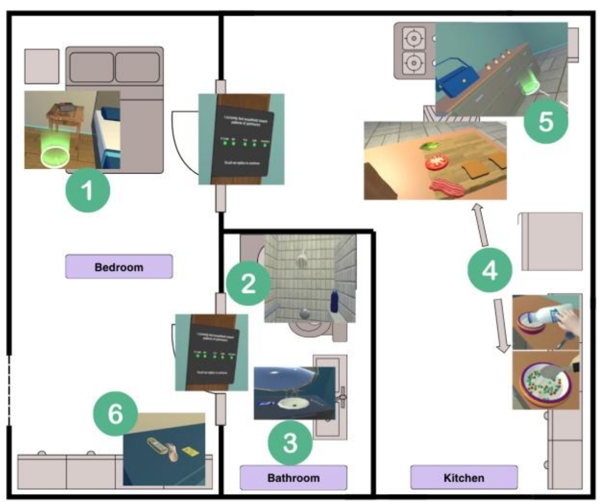

Figure 1. Overview of the Parkinson's disease VR simulation environment. The numbered markers show the room-based task sequence and embedded doorway survey points across the bedroom, bathroom, and kitchen routine.

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Table 1
Simulation segments, tasks, and data checkpoints.

Segment	Included tasks	Data collected
Bedroom	Alarm	Door survey 1 (pre-bathroom)
Bathroom	Shower, Toothbrush	Task performance logs; Door survey 2 (post-bathroom)
Kitchen	Cereal, Food, Pills	Task performance logs; Door survey 3 (post-kitchen)
Bedroom	Phone	Task performance logs

3.2 Classroom Implementation

The study was conducted in a classroom-based learning context using data collected during student interaction with the VR simulation. Participants completed the simulation as an experiential learning activity and generated both survey and gameplay data during the same session. The dataset used in this analysis included 47 participants with complete doorway survey records and gameplay logs. The study protocol was reviewed by the Institutional Review Board and determined to qualify as Exempt Research. All data analyzed in this paper were de-identified before analysis.

The classroom setting is important because the simulation was intended to be used as an educational tool rather than as a controlled laboratory task alone. As a result, the evaluation emphasizes feasibility and interpretable classroom data, including whether embedded measures can be collected during normal use and whether gameplay logs can provide meaningful information about participant experience.

3.3 Embedded Doorway Survey

To capture empathy-related responses during the experience, the simulation presented short doorway surveys at three room-transition checkpoints: pre-bathroom, post-bathroom, and post-kitchen. These checkpoints were positioned after meaningful segments of the routine so that participants could reflect while still immersed in the simulation.

The first survey appeared when participants transitioned from the bedroom to the bathroom, after the opening alarm task, and before the bathroom tasks. The second appeared when participants left the bathroom after completing showering and tooth brushing and returned through the bedroom transition area before entering the kitchen. The third appeared after the kitchen sequence, which included cereal preparation, food preparation, and medication selection, before the final phone task. This design avoided interrupting every task while still capturing responses at important moments in the routine.

At each checkpoint, participants responded to the item: "I currently feel empathetic toward patients with Parkinson's disease." Responses were recorded on a five-point Likert scale coded as follows: 0 = strongly agree, 1 = agree, 2 = neutral, 3 = disagree, and 4 = strongly disagree. Lower values therefore indicate stronger agreement with the item. Because the survey was embedded within the VR environment, it functioned as a lightweight, single-item in-situ measure of immediate empathy-related response rather than a replacement for a full validated empathy instrument.

3.4 Gameplay Performance Metrics

The system logged task-level performance data across six activities of daily living: showering, tooth brushing, cereal preparation, food preparation, medication selection, and phone use. Logged variables included task time, score, and object drops. These variables were selected because they reflect different aspects of task burden. Time captures how long participants needed to complete each task; drops capture interaction difficulty during object handling; and score combines task progress with

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remaining time.

The score combined remaining time and subtask completion:

$$S_{\text{total}} = \sum_{i=1}^{n} t_i + 100 \sum_{i=1}^{n} c_i \qquad (1)$$

where n is the number of tasks, t_i is the remaining time for task i, and c_i is the number of completed subtasks for task i. The maximum timers were 90 seconds for showering, tooth brushing, food preparation, medication selection, and phone use, and 120 seconds for cereal preparation. If participants exhausted the available time for a task, the system advanced them to the next task.

3.5 Analysis Approach

We analyzed two forms of embedded data: doorway survey responses and gameplay performance logs. Descriptive statistics were used to summarize survey distributions and task performance. Because the doorway survey responses were ordinal, exploratory relationships between survey responses and performance metrics were examined using Spearman correlations.

To align the analysis with the simulation structure, segment-level performance measures were created by grouping bathroom tasks and kitchen tasks according to the corresponding doorway checkpoints. The bathroom segment included showering and tooth brushing, while the kitchen segment included cereal preparation, food preparation, and medication selection. This allowed survey responses to be interpreted in relation to the task sequence that participants had just completed.

4. RESULTS

4.1 Doorway Survey Responses

All 47 participants completed the doorway survey item, "I currently feel empathetic toward patients with Parkinson's disease," at the three checkpoints. Responses were generally concentrated in the strongly agree and agree categories. Mean ratings were 0.60 (SD = 0.68) for the pre-bathroom checkpoint, 0.87 (SD = 0.92) for the post-bathroom checkpoint, and 0.64 (SD = 0.85) for the post-kitchen checkpoint. Table 2 summarizes the descriptive statistics for the three doorway survey checkpoints. Because lower values indicate stronger agreement, these results suggest favorable empathy-related responses across the three transition points.

The response distributions are shown in Figure 2. At the pre-bathroom checkpoint, 89.4% of participants selected strongly agree or agree. At the post-bathroom checkpoint, 76.6% selected strongly agree or agree, with a larger neutral/disagree proportion than the other checkpoints. At the post-kitchen checkpoint, 87.2% selected strongly agree or agree. Overall, the post-bathroom checkpoint showed the weakest endorsement and greatest response spread, while the first and third checkpoints showed stronger agreement.

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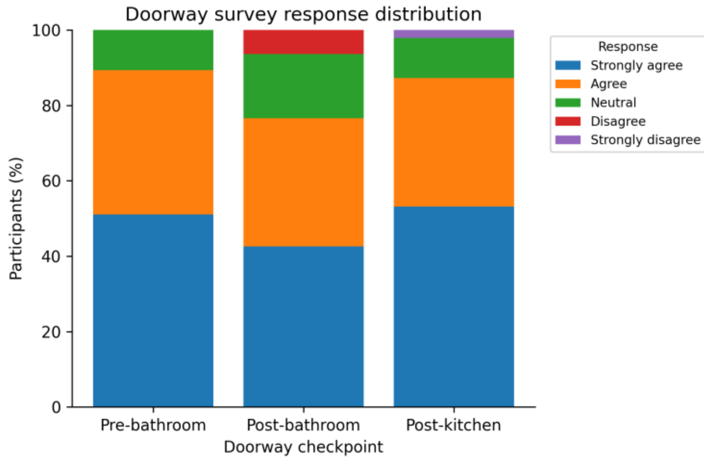

Figure 2. Distribution of doorway survey responses across the three transition checkpoints. Lower-coded responses indicate stronger agreement.

Table 2
Doorway survey responses (N = 47). Lower values indicate stronger agreement.

Checkpoint	M (SD)	Median	SA/A
Pre-bathroom	0.60 (0.68)	0	89.4%
Post-bathroom	0.87 (0.92)	1	76.6%
Post-kitchen	0.64 (0.85)	0	87.2%

4.2 Gameplay Performance

Task-level gameplay performance is summarized in Table 3. Gameplay logs showed meaningful variation in task difficulty across the six daily living tasks. As shown in Figure 3, cereal preparation had the longest mean elapsed time ($M = 113.92$ s, $SD = 14.70$), suggesting that it was the most time-constrained task in the sequence. As shown in Figure 4, pill interaction produced the highest mean number of object drops ($M = 5.96$, 95% bootstrap CI [1.51, 13.06]), followed by cereal preparation ($M = 5.28$, 95% bootstrap CI [2.06, 10.38]). Table 3 also shows that cereal preparation had the lowest mean score, consistent with its longer completion time and greater interaction burden. These results suggest that kitchen-related tasks created the greatest interaction burden, particularly for tasks involving fine motor control and object handling.

Figure 3 visualizes task completion time across the six tasks. The cereal task was closest to its maximum time and therefore appeared to be the most time-constrained task in the sequence. Drop-count distributions were right-skewed, with several high outliers. For example, the maximum observed drop counts were 52 for showering, 103 for cereal preparation, and 131 for pills, while the corresponding medians were 0, 1, and 0. Therefore, object-drop results are interpreted descriptively as indicators of interaction burden. These patterns indicate that different tasks created different forms of challenge, including time pressure, object manipulation difficulty, and precision control.

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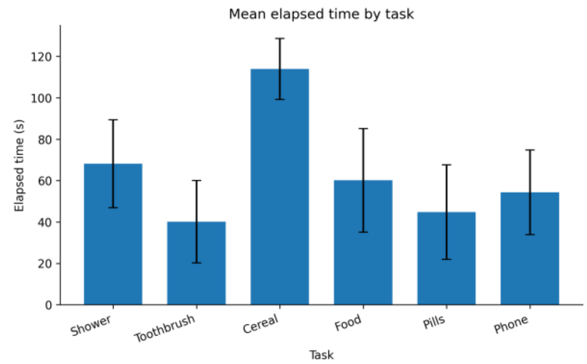

Figure 3. Mean elapsed time by task across the six simulation tasks. Error bars represent standard deviation.

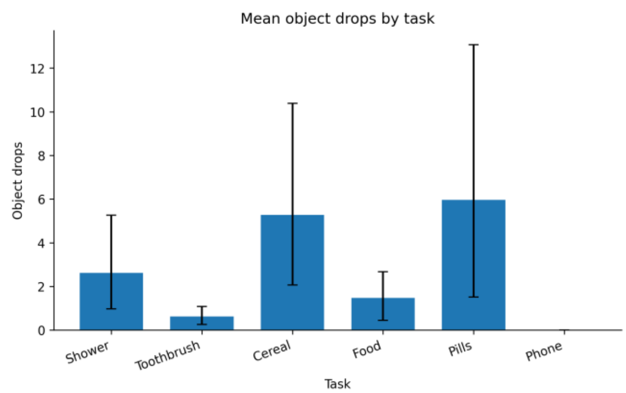

Figure 4. Mean object drops by task. Error bars show 95% bootstrap confidence intervals.

Table 3. Task-level gameplay performance (N = 47; valid N varies for drop measures due to incomplete logs).

Task	Time M (SD)	Score M (SD)	Drops M (SD); Median [Max]
Shower	68.19 (21.25)	268.23 (106.80)	2.62 (7.93); 0 [52]
Toothbrush	40.12 (19.86)	451.55 (310.38)	0.62 (1.47); 0 [8]
Cereal	113.92 (14.70)	163.45 (105.87)	5.28 (15.48); 1 [103]
Food	60.13 (25.03)	272.09 (123.61)	1.48 (3.61); 0 [13]
Pills	44.78 (22.86)	232.00 (60.78)	5.96 (20.72); 0 [131]
Phone	54.33 (20.48)	316.13 (71.53)	0.00 (0.00); 0 [0]

4.3 Relationships Between Survey Responses and Performance

We explored whether embedded empathy responses were associated with gameplay performance. The post-bathroom survey rating was compared with bathroom-segment performance, including shower and tooth-brushing time, score, and drops. The post-kitchen survey rating was compared with kitchen-segment performance, including cereal, food, and pill task metrics. Spearman correlations were used because the doorway survey responses were ordinal.

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Associations were small and not statistically significant. For the post-bathroom checkpoint, correlations with bathroom time, score, and drops were rho = -0.032, $p = .833$; rho = 0.125, $p = .403$; and rho = 0.042, $p = .782$, respectively. For the post-kitchen checkpoint, correlations with kitchen time, score, and drops were rho = 0.096, $p = .519$; rho = -0.117, $p = .434$; and rho = 0.008, $p = .962$, respectively. These results indicate that doorway survey ratings were not strongly associated with the logged performance metrics in the corresponding task segments.

Together, the results show that the simulation consistently produced positive in-situ empathy responses while also creating measurable gameplay challenges. The weak association between survey responses and performance metrics suggests that the doorway survey may capture a broader affective or interpretive response to the first-person simulation, rather than task difficulty alone.

5. DISCUSSION

This study extends earlier Parkinson's disease VR work by examining empathy-related responses captured during the simulation rather than relying only on post-experience feedback. Across all three doorway checkpoints, participants generally selected strongly agree or agree, indicating consistently positive empathy-related responses throughout the experience. At the same time, gameplay logs showed clear differences in task difficulty, with the kitchen sequence, especially cereal and pill interactions, appearing more demanding than several other tasks. Together, these findings suggest that the simulation was able to evoke empathic reflection while also presenting meaningful task challenges.

One important finding is that positive empathy-related endorsement appeared throughout the simulation rather than only at the end. This supports the use of lightweight survey prompts at natural transition points. Instead of asking participants to reflect only after leaving VR, the doorway surveys captured responses while they were still immersed in the routine. For empathy-oriented simulations, this is useful because perspective-taking may develop gradually as participants move through the experience.

The post-bathroom checkpoint showed slightly weaker ratings than the other two transitions. One possible explanation is that this point occurred early in the simulation, after participants had begun adjusting to the controls and tremor-based interaction difficulty. By the final checkpoint, participants had experienced a longer sequence of daily living challenges, which may have strengthened their understanding of the burden associated with Parkinson's disease. This pattern suggests that empathy-related responses may shift with both exposure time and task accumulation, although this interpretation should be treated cautiously because the doorway survey was a single-item state measure.

The gameplay data help explain how the simulation functioned as an experiential learning environment. Cereal preparation had the longest average completion time and one of the lowest mean scores, while pill interaction also produced a relatively high number of drops. These findings are consistent with the design intent of the simulation. Tasks that require precision, steadiness, and repeated object handling are more likely to highlight the frustration associated with tremor and impaired fine motor control. In this way, the system translates Parkinson's disease symptoms into interactive barriers rather than only describing them.

At the same time, the associations between doorway survey ratings and performance metrics were weak and non-significant. Participants who took longer, dropped more objects, or earned lower scores did not necessarily report stronger empathy-related endorsement. This does not mean that either data source was uninformative. Instead, it suggests that self-reported empathy and gameplay telemetry captured different dimensions of the experience: subjective interpretation of the patient perspective and behavioral performance under simulated motor constraints.

This result also suggests that doorway surveys and gameplay metrics capture different aspects of the experience. Performance measures reflect how participants managed the motor demands of the tasks, while doorway surveys appear to reflect a broader affective or interpretive response to being placed in

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the role of a person living with Parkinson's disease. This interpretation aligns with prior work on embedded assessment and serious-game analytics, where gameplay behavior and learner response are treated as complementary sources of evidence rather than interchangeable measures (Shute, 2011; Caballero-Hernandez et al., 2017). For future work, this distinction is important because greater frustration or poorer performance should not automatically be assumed to produce stronger empathy.

Methodologically, this study contributes a practical way to evaluate empathy-oriented VR in classroom settings. Many VR education studies rely on pre/post measures or post-session reflection. Those approaches remain useful, but they provide limited information about how responses develop during the experience. The transition-based doorway survey used here offers a lightweight in-situ alternative that fits naturally into the simulation flow and can be paired with gameplay telemetry for richer analysis.

Several design implications follow from these findings. First, transition-based prompts appear to be a feasible way to capture state responses without heavily disrupting immersion. Second, tasks involving precise hand control, such as cereal and pill interactions, seem especially effective for surfacing the kinds of daily frustrations central to the Parkinson's disease experience. Third, because positive empathy-related responses were observed even without strong performance-response associations, designers may not need to maximize failure to support perspective-taking. A balanced combination of challenge, context, and pacing may be more effective for classroom use.

This study has several limitations. The sample size was modest, and the doorway survey included only three transition checkpoints rather than continuous or task-level reporting. The doorway item should be interpreted as a lightweight in-situ empathy check, not as a replacement for a validated empathy instrument. The drop-count variables were also right-skewed, so they are best interpreted descriptively. More broadly, the study addresses immediate in-game responses rather than long-term changes in empathy, attitudes, or professional behavior.

Future work should combine embedded transition-based measures with post-session reflection, qualitative data, or validated pre/post empathy instruments. It would also be valuable to examine whether specific design features, such as adaptive difficulty, weighted utensils, or hallucination events, influence both performance and empathetic response. These directions would help clarify which elements of immersive simulation most effectively support perspective-taking in healthcare education.

Overall, the findings support the Parkinson's disease VR simulation as a useful classroom-based experiential learning tool. The study also shows that transition-based in-situ assessment is a feasible method for evaluating empathy-oriented VR experiences. By combining embedded self-report with gameplay data, this work offers a more process-sensitive approach to studying perspective-taking in immersive healthcare education.

6. CONCLUSION

This study demonstrates that a Parkinson's disease VR simulation can evoke consistent empathy-related responses across classroom learners when assessed through lightweight doorway surveys embedded at natural transition points. The findings indicate that kitchen-based tasks involving fine motor control, particularly cereal preparation and medication selection, produce the greatest measurable interaction burden, while embedded empathy endorsement remains positive regardless of individual performance variation.

The weak association between in-game performance and self-reported empathy suggests that the embedded survey and telemetry measures captured complementary aspects of the VR experience. Rather than indicating that task struggle directly predicted empathy-related response, the findings suggest that participants' broader interpretation of the first-person routine may be important for perspective-taking.

Methodologically, the combination of transition-based self-report and gameplay telemetry offers a practical, process-sensitive evaluation framework for immersive healthcare education. Future research should integrate these embedded measures with validated empathy instruments, qualitative reflection,

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and longitudinal assessment to examine sustained attitude change. Extending this approach to other chronic conditions may further establish VR as a scalable tool for experiential learning in interprofessional health education.

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