



Design and Implementation of an Educational Game for Visual Impairment: A Study Based on the Experiential Gaming Model

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Abstract. In China, approximately 1 in every 100 individuals is visually impaired. Traditional media often fall short of conveying the complexities associated with visual impairment, and can inadvertently propagate stereotypes. Addressing this knowledge gap requires an innovative medium facilitating a deeper understanding and interaction with the visually impaired population (VIP). This study proposes an interactive, game-based learning experience designed to increase public awareness and acceptance of VIPs, known as "The Lightness Road." The game leverages the Experiential Transformative Game-based Learning Model, integrating experiential learning and transformative learning theories to engage users in a narrative that simulates real-life challenges faced by VIPs. User testing indicates that the game surpasses traditional media in educating about blindness awareness, improving attitudes toward VIPs, and providing an engaging and effective learning experience.

Keywords: experiential learning, transformative learning, visual impairment awareness, game-based learning, interactive media

1 Introduction

Experiential learning, particularly through role-playing, has emerged as a powerful educational approach, enabling learners to immerse themselves in the realities of visually impaired individuals [1,2]. Existing initiatives like "Dialogue in the Dark" and games like "Blindfold" have succeeded in raising awareness but are often restricted in scope due to their reliance on physical venues and direct contact, which may not be feasible or accessible to all audiences. These limitations necessitate a transformative learning approach that reframes learners' perspectives and challenges pre-existing biases [3]. The success of experiential learning hinges on the effective allocation of attention resources, a crucial consideration given the overwhelming abundance of information vying for cognitive engagement in the modern era. Emergent narratives offer a compelling solution, providing a non-linear, player-driven storytelling ap-

proach that can maintain learners' focus and intrigue [4]. By intertwining the exploratory freedom of emergent storytelling with the focus required for transformative learning, we can create educational experiences that not only capture attention but also facilitate profound learning outcomes [5].

This paper advocates for a novel educational paradigm that integrates experiential role-play, transformative learning, and emergent narratives within the framework of gaming to enhance public understanding and acceptance of the visually impaired community [6].

2 Method

2.1 Developing the Experiential Transformative Game-based Learning Model: A Methodological Framework

This section elucidates the theoretical underpinnings and practical implementation of the Experiential Transformative Game-based Learning Model, developed for educating the public about the visually impaired community through interactive gaming experiences [8]. The game model emphasizes active experimentation and reflection, driven by gameplay that fosters curiosity and exploration. Core aspects include:

- **Direct Experience:** By simulating the perception and actions of visually impaired individuals, the game provides a platform for players to engage in challenges that replicate real-life scenarios of the visually impaired.
- **Active Experimentation:** With clear goals and engaging mechanics, the game encourages players to explore and experiment within its universe, reinforcing the educational objectives through interactive experiences.
- **Observation and Reflection:** The game's immersive environment and narrative encourage players to reflect on their experiences, fostering a deeper understanding of the challenges faced by visually impaired individuals.

The Experiential Transformative Game-based Learning Model's design is predicated on achieving an optimal balance between educational depth and engaging gameplay. This model prioritizes the cohesiveness of the gaming experience while ensuring each educational fragment garners sufficient attention. With a structured logic that scales from educational foundations to gaming mechanics, the model enhances the design and implementation efficiency of the game centered on visual impairment education. The next section delves into the design and implementation strategies of the experiential transformative game "The Road of Darkness," with a particular emphasis on in-game experience simulation and emergent narrative design based on the Experiential Transformative Game-based Learning Model.

2.2 Vision Impairment Experience Design and Implementation Based on Game 3C

"The Road of Darkness" endeavors to closely replicate the experiences of visually impaired individuals (VIPs) within a virtual environment, challenging players to navigate daily inconveniences and obstacles to deepen understanding and empathy to-

ward the VIP community^[9]. The game's character design is pivotal to the simulation experience, detailed here under the game development concept known as the "3C": Character, Camera, and Control.

Character Design and Implementation

In "The Road of Darkness," characters are designed with unique features to simulate visual impairment: The technical implementation utilizes Unreal Engine's blueprint system for character development, with highlighted outlines and interactive animations based on character speed and cane usage.

Camera and Control Design and Implementation

The game's camera mimics VIPs' perception by restricting the field of view to the front, challenging players to rely on auditory cues and other senses to navigate. A third-person perspective aids players in spatial judgment while maintaining accessibility and immersion. Controls are simplified to reflect the exploratory nature of VIPs' movements, with keyboard and mouse inputs dictating forward movement and orientation. A deliberate design choice ensures players face the same constraints as VIPs, fostering an authentic and empathetic gaming experience.

2.3 Interactive Design and Implementation Based on the Experiential Game Model

Following the 3C's vision impairment simulation, "The Road of Darkness" leverages interactive design to facilitate familiarization with the abstract character experience and guide player exploration.

Goals and Feedback

Interactive interface elements provide real-time feedback, key to players achieving game objectives. A UI conveys critical information such as task prompts, character stamina, and interaction cues, all essential for navigation and decision-making within the game environment.

Core Gameplay Loop Based on Control Sensation and Skill Growth

A core gameplay loop, revolving around map exploration, is introduced, aligning with the game model's design principles. This loop caters to both experienced and novice players by providing multiple strategies for game completion, accommodating varying player skills.

Attention Guidance

Artistic and audio effects guide player attention, with abstract visuals and realistic soundscapes enriching the gameplay experience. Textual elements display instruc-

tions, storylines, and educational content, structured to ensure comprehension without overwhelming the player.

2.4 Non-linear Narrative Design and Implementation Integrating Diverse Educational Content

Fragmented Narrative Design for Vision Impairment Awareness

"The Road of Darkness" employs fragmented narratives to blend experiential learning with transformative learning effects. Game elements serve dual functions in education and gameplay, delivering content through interactive points of interest and storytelling.

Open-world Exploration and Emergent Narrative Implementation

An open-world map design facilitates emergent storytelling as players craft unique paths to objectives, creating personal narratives. The game's map system assists in spatial orientation without direct player positioning, simulating the real-world navigation challenges VIPs encounter.

2.5 Evaluating the Effect of "The Road of Darkness"

To ascertain whether "The Road of Darkness" achieved its educational goals compared to other science popularization media. The study focused on the cognitive and attitudinal shifts in participants after using different forms of media and evaluating their learning and gaming experiences.

Evaluation Metrics

A mixed-method research approach utilized questionnaires to measure knowledge, attitudes, and practices (KAP), learning and gaming experience, as well as empathetic and sympathetic responses before and after the intervention [7].

Participant Profile and Experimental Groups

In Table 1, 96 graduate-level individuals were recruited for an online comparative experiment, resulting in 91 valid samples across three groups: those who played "The Road of Darkness," those who played a similar game "Jian", and those who viewed educational videos. Initial data showed consistency across groups in terms of gender, age, and basic knowledge of visual impairments, setting a baseline for a controlled comparison.

Table 1. Sample Characteristics Chi-Square Results

Variable	Option	The Road of Darkness (%)	Game B (%)	Video (%)	Total	χ^2	<i>p</i>
Gender	Male	18 (60.00)	21 (72.41)	16 (50.00)	55 (60.44)	3.200	0.202
	Female	12 (40.00)	8 (27.59)	16 (50.00)	36 (39.56)		
Age	18-25	26 (86.67)	27 (93.10)	26 (81.25)	79 (86.81)	3.514	0.476
	26-30	4 (13.33)	1 (3.45)	5 (15.63)	10 (10.99)		

3 Results & Discussion

3.1 Comparative Efficacy on Knowledge Acquisition

The results indicate that "The Road of Darkness" significantly improved participants' knowledge about visual impairments more effectively than "Jian" and educational videos. This enhancement is attributed to the game's immersive experiential learning environment, which was designed to simulate the sensory experiences of visually impaired individuals. A one-way ANOVA showed that the mean post-intervention knowledge scores were significantly higher for the "The Road of Darkness" group ($M = 27.90$, $SD = 3.83$) than both "Game B" ($M = 19.31$, $SD = 4.29$) and video group ($M = 23.91$, $SD = 3.22$), $F(2, 88) = 37.982$, $p < 0.001$, indicating an effective educational intervention through the game.

Table 2. Basic Cognition Before and After Intervention

Group	Pre-Test $M \pm SD$	Post-Test $M \pm SD$	Difference	<i>t</i>	<i>p</i>
The Road of Darkness	22.10±3.64	27.90±3.83	+5.80	11.839	<0.001**
Game B	20.24±3.93	19.31±4.29	-0.93	-1.402	0.172
Video	20.91±3.27	23.91±3.22	+3.00	4.406	<0.001**

The data presented in Table 2 shows a significant improvement in cognitive scores for participants of "The Road of Darkness," indicating a clear educational benefit over watching videos or playing "Game B," which did not effectively correct misconceptions about visual impairments.

3.2 Empathy Analysis Across Different Interventions

To further clarify the effect on empathy, we explore the differences in empathy outcomes among participants who engaged with "The Road of Darkness," Game B "Jian", and educational videos, providing pre- and post-intervention comparisons. The results (Table 3) illustrate significant improvements in empathy scores for participants

of "The Road of Darkness," compared to minimal changes observed in "Game B" and moderate improvements in the video group. The data indicates that "The Road of Darkness" not only facilitate better cognitive understanding, but it also fostered a deeper sense of empathy towards the visually impaired community, a critical outcome that was less pronounced in the other forms of media.

Table 3. Comparative Analysis of Empathy Scores

Goup	Pre-Test Empathy Score	Post-Test Empathy Score	% Change	<i>t</i>	<i>p</i>
The Road of Darkness	3.5 ± 0.8	4.2 ± 0.7	+20%	5.042	<0.001**
Game B	3.6 ± 0.7	3.7 ± 0.8	+2.8%	0.879	0.382
Video	3.5 ± 0.9	3.8 ± 0.9	+8.6%	2.196	0.031*

3.3 KAP Analysis Across Different Interventions

In terms of behavior, "The Road of Darkness" prompted more positive behavioral intentions towards the visually impaired. This suggests that the game's design, which integrates real-life challenges faced by visually impaired individuals into its gameplay, effectively influenced players' attitudes and intended behaviors. This impact highlights the potential of serious games as tools for social change, particularly in promoting inclusivity and understanding for marginalized communities. Table 4 shows that the games tend to yield a higher change in attitude compared to the video group, suggesting interactive media might be more effective in enhancing audience engagement and acceptance of the visually impaired community.

Table 4. Variance Analysis of Attitude Dimensions Among Groups

Group	Post-Intervention Attitude (<i>M</i> ± <i>SD</i>)	Attitude Change (<i>M</i> ± <i>SD</i>)	<i>F</i>	<i>p</i>
The Road of Darkness	16.73±2.30	0.97±1.69	2.937	0.058
Game B	17.10±2.16	1.28±1.81		
Video	16.16±1.95	0.16±2.08		

Using the Chi-square test (cross-analysis) to study the experimental groups' preferences for behavior items P1-P4, the summary of results in Table 6 shows that there are no significant differences among different experimental groups for items P3 and P4 ($p > 0.05$); however, there are significant differences for items P1 and P2 ($p < 0.05$).

3.4 Learning and Gaming Experience Analysis

The game also excelled in providing a compelling learning and gaming experience. Participants reported high levels of content immersion and enjoyment, which were significantly higher than those reported by participants who interacted with "Jian" and

watched educational videos (Table 5). This superior user experience is critical in educational settings, as it not only sustains engagement but also enhances information retention and empathetic understanding.

Table 5. Learning Experience Comparison between Groups

Metric	The Road of Darkness Median (P25, P75)	Game B (P25, P75)	Mann-Whitney U	Z	p
Learning Experience	3.85 (3.58, 4.12)	3.75 (3.45, 4.00)	166.500	-4.464	0.000**

Participants also rated their willingness to continue playing and overall enjoyment higher in "The Road of Darkness" compared to "Jian," which can be seen in the analysis of gameplay sequence preferences and overall game experience ratings. There is a clear preference for "The Road of Darkness" over "Jian" in terms of content enjoyment and the willingness to continue playing, indicating its effectiveness in engaging players more deeply and providing a richer educational experience.

Table 6. Subjective Comparison of Game Experience between Groups

Aspect	The Road of Darkness (%)	Game B (%)	Chi-square	p
Content Immersion	41.94	51.61	6.290	0.012*
Content Enjoyment	58.06	38.71	8.310	0.004**
Presentation Style	32.26	61.29	7.102	0.008**
Further Gameplay Willingness	54.84	35.48	6.198	0.013*
Science Popularization Impact	58.06	29.03	7.530	0.006**
Overall Experience	58.06	35.48	8.214	0.004**

4 Conclusion

"The Road of Darkness" was developed to address the social exclusion faced by visually impaired individuals by enhancing public understanding and empathy through interactive gameplay. This game exemplifies the integration of experiential and transformative learning theories with game-based learning, aiming to simulate the challenges faced by the visually impaired and prompt players to reconsider their preconceptions. The study confirmed that the game significantly improved knowledge, attitudes, and behaviors towards the visually impaired, more effectively than traditional educational methods and another game, "Jian." It fostered a deep sense of empathy and understanding, showcasing serious games as potent tools for education and social change. Participants not only learned about visual impairments but also demonstrated positive changes in their behavioral intentions, highlighting the game's success in promoting inclusivity. These findings advocate for the broader use of such immersive games in educational settings to enhance empathy and awareness dynamically. Future

research should expand on these results by assessing long-term effects and exploring adaptability across diverse educational contexts.

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