Designing for Ideological Flexibility: Tracking Perspective Shifts in an Educational IDN

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Abstract. This study investigates how interactive digital narratives (IDNs) can foster systems thinking and ideological flexibility in secondary learners by engaging them with ideologically diverse stakeholder perspectives. Grounded in the Context–Learning–Game (CLG) framework, the intervention integrates Emily Short's Track Switching Choice structure and a non-playable character (NPC) functioning as a more-knowledgeable other (MKO) to scaffold learner engagement while exploring a complexity representation tool called Transformation Maps. Set within a simulated organizational debate on artificial intelligence, the narrative prompts learners to explore and synthesize viewpoints from three stakeholders. Behavioral data from gameplay logs, including perspective-switching frequency, time-on-task, and MKO interactions, were analyzed as indicators of ideological flexibility. Results show that most learners reconsidered their initial positions, with a significant number adopting more moderate viewpoints. Learners who switched perspectives spent more time in the experience, and MKO engagement strongly predicted final viewpoint change. A specific narrative moment, tagged Dhwani8, emerged as a cognitive inflection point associated with epistemic shift. These findings suggest that well-designed IDNs can reduce cognitive overload, support ideological exploration, and serve as analytic instruments for measuring learning behavior and epistemic development in complex decision-making contexts.

Keywords: Systems Thinking · Interactive Digital Narrative · DSRP Framework · Zone of Proximal Development · Constructionism · Serious Game · Pedagogical Tools · Complex Systems

1 Introduction

Today's complex world demands critical thinking, adaptability, and the ability to synthesize diverse perspectives. Traditional education often falls short in equipping learners with these cognitive tools. In response, this paper investigates the potential of interactive digital narratives (IDNs), particularly educational IDNs, to foster systems thinking and ideological flexibility by enhancing learners' ability to explore, interpret, and reflect on multiple perspectives.

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IDNs provide participatory environments where learners engage with complex systems through structured, exploratory storytelling. Such environments are particularly suited for tackling "wicked" problems—ill-defined, dynamic, and socially entangled challenges that resist simple solutions [1].

Janet Murray's ICIDS 2018 keynote described IDNs as "kaleidoscopic machines," tools for analyzing events from multiple perspectives and imagining alternative futures [2]. We extend this metaphor to frame IDNs as epistemic engines for iterative perspective-taking and knowledge reorganization, aligning with theories of cognitive tools and epistemic games [3, 4].

In keeping with this design philosophy, we incorporated the World Economic Forum's (WEF) Transformation Maps as the systems thinking foundation of our intervention. These interactive digital tools help visualize thematic relationships across complex global issues such as AI, biodiversity, immigration and more. However, a previous study [5] found that without scaffolding, the maps can be cognitively overwhelming and fall outside learners' Zone of Proximal Development (ZPD) [6]. To improve the user experience and reduce cognitive load, we transformed the interactive digital exploration of the maps into an interactive digital *narrative* experience through the addition of narrative storytelling elements. This redesign incorporated the maps into a mobile game format and embedded a non-playable character (NPC) acting as a more knowledgeable other (MKO).

The present research centers on the design and evaluation of an educational IDN, a narrative-based educational game that integrates Emily Short's Track Switching Choice structure with the DSRP (Distinctions, Systems, Relationships, Perspectives) framework for systems thinking [7]. Set within the WEF's map on AI and grounded in Vygotsky's guided learning, the design uses narrative scaffolding to make systemic relationships more accessible and relevant to learner decision-making. The user adopts the role of a company mediator, facilitating discussion among three stakeholder characters: an employee, the CEO, and a customer. When needed, the user invokes the MKO Dhwani character to highlight specific concepts on the system map and support decision-making. Each time the user shifts perspective, the system logs these switches, recording initial and final viewpoints along with gameplay behaviors for later evaluation on how understanding and ideologies evolve.

The central research question (RQ) guiding this work is: *How can IDNs be used to measure the impact of exposure to multiple perspectives on learners' ideological flexibility?* Supporting this overarching inquiry are three sub-questions (SRQ): *(1) Can the design of an IDN expose players to diverse stakeholder perspectives in a way that promotes systems thinking? (2) How can Emily Short's Track Switching Choice structure be adapted to provide measurable insights into player behavior and ideological flexibility? (3) What is the impact of an NPC functioning as a MKO on learners' exploration patterns and comprehension of complexity?*

While the goal is to foster ideological flexibility, the openness to revisiting assumptions, this study examines behavioral and reflective indicators of ideological flexibility rather than long-term belief change.

2 Background and Related Work

This research lies at the intersection of systems thinking and dynamics, human-computer interaction (HCI), interactive narrative design, serious games, and educational technology, specifically with regard to media and digital literacy [8]. Within these domains, several conceptual and theoretical frameworks underpin the study's design and analysis.

2.1 Systems Thinking and Educational Challenges

Systems thinking has long been advocated as an essential capacity for addressing the increasingly complex challenges of the 21st century. From Richmond's articulation of systems thinking as a set of transferable skills [9] to the development of structured frameworks like DSRP [10], scholars have emphasized the need to support learners in identifying feedback loops, interdependencies, and causal relationships across domains. Despite this, systems thinking remains underutilized in education, partly due to its abstract nature and the difficulty of modeling dynamic complexity within conventional instructional formats.

The DSRP model offers an accessible and teachable approach to systems thinking by organizing cognition into four core patterns: making Distinctions (D), organizing Systems (S), recognizing Relationships (R), and taking Perspectives (P) [11]. Research suggests that engagement with these patterns enhances learners' ability to analyze complex issues and reflect on cognitive biases. In this study, DSRP functions as both a pedagogical foundation and a design scaffold for the game's narrative structure, mechanics, and dialogue interactions.

To operationalize systems thinking in a digital context, we incorporated the WEF's Transformation Maps—interactive data visualization tools that organize global issues and their relationships. These maps, while rich in systemic content, can overwhelm novice users [5]. By embedding them into a narrative learning environment, we enabled learners to apply DSRP principles through structured gameplay. Players used the maps to differentiate core concepts, identify subsystems (e.g., governance, labor, innovation), explore relationships between variables, and shift among stakeholder perspectives—all supported by narrative scaffolding through an NPC acting as a MKO.

While systems thinking is a powerful tool for analyzing complexity, its utility extends into the realm of media literacy [12]. As digital media increasingly shapes the way information, values, and ideologies are disseminated, the ability to navigate this complexity becomes essential. Educational systems, however, have been slow to adapt, leaving students ill-equipped to interpret the dynamic media landscapes they inhabit. In this sense, media literacy functions as a form of public pedagogy, with learners constantly exposed to persuasive, politicized, and ideologically charged narratives [13]. Developing media literacy involves more than technical competence; it requires critical awareness of how meaning is constructed. Systems thinking complements this process by encouraging learners to ask not only what is being communicated, but how elements are connected, who benefits, and what systems are being reproduced. Together, these literacies provide the cognitive infrastructure for navigating complexity and combating misinformation in digitally-mediated environments.

2.2 IDNs and Narrative Foundations

IDNs are digital artifacts where users participate in story progression through meaningful choices, often navigating branching pathways, variable outcomes, or emergent gameplay structures. Koenitz (2023) conceptualizes IDNs as a form of computational storytelling that facilitates user agency and immersion. When applied to educational contexts, IDNs enable learners to engage with multifaceted content in a personalized and dynamic manner [14].

Researchers have increasingly examined the potential of IDNs as systems thinking tools, capable of helping learners trace interdependencies, shift perspectives, and explore causal relationships in context-rich environments [12]. As dynamic, interactive spaces, narrative-centered environments replicate the complex nature of real-world systems [15], while the digital medium can promote personal transformation and deeper engagement with multiple viewpoints [16]. Together, these affordances make IDNs particularly well-suited to address educational challenges related to polarization and media and systems literacy.

Building on this foundation, narrative structures are understood not merely as storytelling devices but as cognitive tools that facilitate learners' engagement with complex systems. Narratives help to organize abstract and complex information into cause-and-effect sequences, thereby making systemic relationships more cognitively accessible [17]. Storytelling has also been identified as a fundamental method for navigating ambiguity and complexity, particularly in contexts where traditional analytical models may be insufficient [18]. Interactive narratives provide a medium for learners to explore dynamic systems, test alternative decisions, and experience the consequences of various stakeholder viewpoints [19].

In addition to their cognitive utility, narratives also serve an affective function by fostering empathy and facilitating perspective-taking. Immersion in a narrative can reduce resistance to alternative viewpoints, supporting learners in recognizing and considering perspectives that differ from their own [20]. Narratives also help individuals construct and make sense of multiple identities, enabling learners to adopt diverse perspectives and increase ideological flexibility [21].

2.3 Track Switching Choice Structure for Perspective-Switching

In 1979, Random House, Inc., launched an innovative line of books called the Choose Your Own Adventure series. These books set the standard for a literary genre now known as "interactive fiction" [22]. Emily Short has identified a number of structures commonly found in small-scale digital choose your own adventure (CYOA) narratives [23].

One such structure, the Track Switching Choice (see Fig. 1), provides a design pattern that enables and records user navigation between narrative paths associated with different characters or perspectives. Unlike large-scale branching structures such as the Time Cave, which often rely on replay to present multiple perspectives, Track Switching is a micro-structure that supports such perspective shifts within a single playthrough. This makes it particularly promising for educational applications, where sustained engagement within a single session may be more feasible than encouraging repeated replays. While the Track Switching Choice structure is frequently discussed in developer forums

and interactive fiction communities, it has yet to be systematically examined in academic literature. Emily Short, a prominent narrative designer in the field, has significantly shaped discourse around interactive fiction, though her work has not been formalized within traditional peer-reviewed research. To date, no empirical studies have operationalized the Track Switching Choice as a methodological framework in educational contexts.

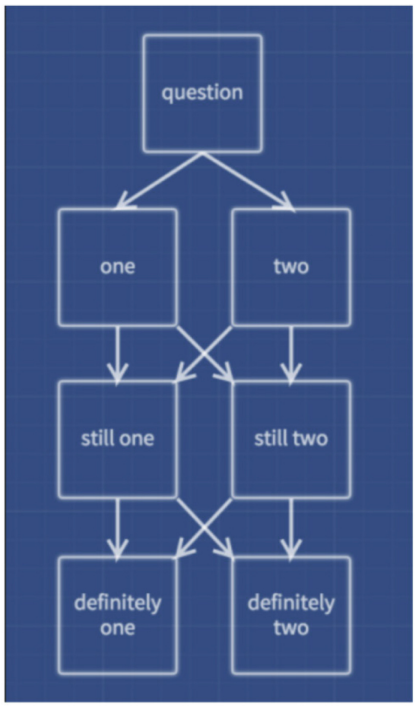

Fig. 1. Emily Short's Track Switching Choice structure illustrates two narrative paths, allowing the player to switch between them freely for several beats. While Short's example features two tracks, the structure can be extended to three or more.

This study, therefore, represents a novel application of the Track Switching Choice structure, not only as a storytelling structure but also as an analytic framework. The structure was leveraged to track how frequently and meaningfully players shifted between three perspectives (see Fig. 2), providing new insights into their narrative decision-making and cognitive strategies. By transforming a storytelling tool into a measurable structure for learner behavior, this work opens a new avenue for research into how interactive narrative systems can be studied as behavioral indicators of epistemic development and ideological flexibility.

Perspective-switching aligns closely with psychological constructs such as epistemic curiosity and the illusion of explanatory depth. Epistemic curiosity, the drive to resolve uncertainty and acquire new knowledge [24], is often triggered when learners confront unfamiliar or conflicting perspectives.

Likewise, the illusion of explanatory depth, which refers to people's tendency to overestimate their understanding of complex phenomena [25], can be disrupted through guided engagement with diverse viewpoints. In this study, the Track Switching

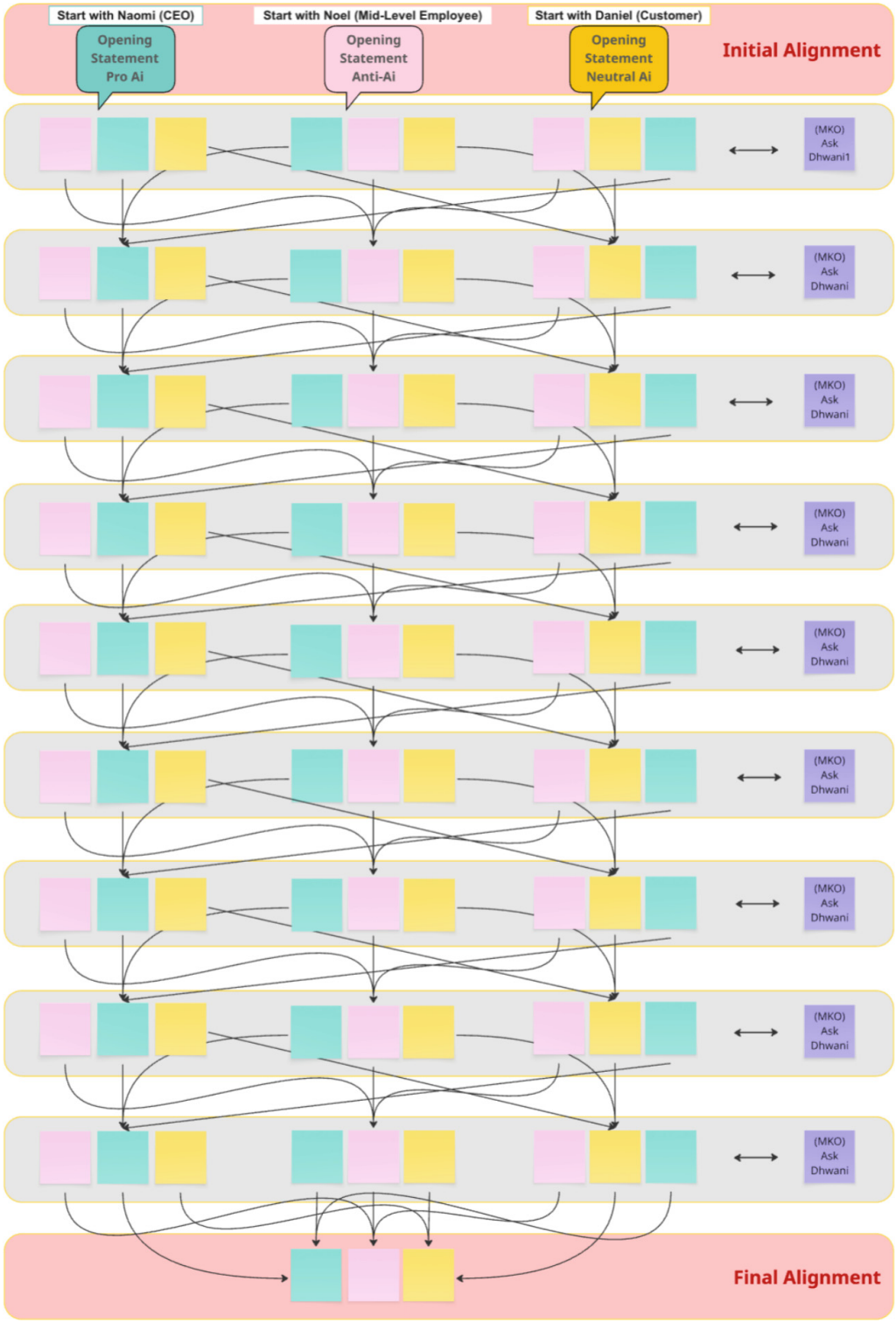

Fig. 2. Short's Track Switching Choice Structure adapted with three tracks.

Choice structure operationalizes both constructs by prompting learners to reconsider assumptions, shift perspectives, and update their mental models.

These mechanisms are not only pedagogically sound but grounded in cognitive science literature linking metacognitive engagement to deeper learning. This study is part of

a broader body of doctoral research exploring systems thinking in education. For the purposes of this paper and in line with the conference theme, we focus specifically on how narrative-driven perspective-switching can stimulate epistemic curiosity and, in turn, foster ideological flexibility. Ideological flexibility refers to the mental ability to shift between concepts and adapt to novel, complex situations. It supports learners in revising assumptions, adopting alternative viewpoints, and navigating wicked problems, core capacities for systems thinking and adaptive learning [26]. Through structured engagement with diverse perspectives and reflective stakeholder narratives, learners enhance both their understanding of systems and their capacity for adaptive reasoning.

This process cultivates adaptive thinking and supports learners' ability to navigate complex, uncertain environments. By inviting players to step into roles with divergent worldviews, the Track Switching Choice structure serves as an experiential tool for developing ideological humility.

2.4 Constructivism, Guided Exploration, and the MKO

Grounded in constructivist learning theory, this study views learning as a socially mediated process shaped by developmental stages, instructional support, and active engagement [6, 27]. Central to this is Vygotsky's Zone of Proximal Development (ZPD), which describes the range within which learners can progress with support from a more knowledgeable other (MKO), a concept not explicitly named by Vygotsky but widely acknowledged in educational theory.

Extending this notion, Metcalfe et al. (2020) introduced the Region of Proximal Learning (RPL), emphasizing learners' intrinsic motivation to engage with slightly beyond-reach tasks [28]. This intrinsic motivation closely parallels the concept of epistemic curiosity discussed in Sect. 2.2. When properly scaffolded, such curiosity can drive deeper engagement—particularly in educational contexts that involve wicked problems.

Constructivist principles in game design often manifest through narrative scaffolding and experiential learning, shown to support critical thinking, systems literacy, and identity exploration [4, 29, 30]. In our study, these principles are embodied in Dhwani, an NPC designed as an MKO. Cast as a peer-like colleague, she offers optional, context-specific support tied to the AI Transformation Map, promoting differentiated learning and maintaining player agency. As prior research [5] showed learners found the maps overwhelming, embedding them within narrative and scaffolding through Dhwani helped reduce cognitive load and enhanced systems-level reasoning.

3 Experimental Design Methodology

To investigate how narrative-driven systems thinking interventions like educational IDNs affect learners' ideological flexibility and perspective-taking, this study employed a mixed-methods design. The central intervention was a narrative-based game that positioned players within a simulated organizational decision-making context, providing scaffolded support in using the Transformation Maps in decision-making.

This study focused on a single group of learners who interacted with a narrative-driven game designed around Emily Short's Track Switching Choice structure. A primary objective was to investigate how this structure could be adapted to yield measurable insights into player behavior and ideological flexibility, aligning with SRQ2: How can Emily Short's Track Switching Choice structure be adapted to provide measurable insights into player behavior and ideological flexibility? Specifically, the study examined whether the Track Switching mechanism could facilitate systems thinking (SRQ 1) and offer a lens through which to analyze learners' knowledge construction and engagement with complex, ideologically diverse content. While the overall research question is to understand how to promote ideological flexibility, defined as the capacity to entertain, understand, and empathize with divergent viewpoints, this study did not attempt to measure ideological change directly. Instead, it assessed behavioral indicators of ideological flexibility and openness to multiple perspectives, such as the frequency of perspective-switching, interaction with the MKO (SRQ 3) and evidence of other phenomena captured through gameplay interaction logs.

The game utilized structured dialogues embedded in a role-play scenario supported by a systems thinking framework, aiming to track learners' behavioral interactions, shifts in perspective, and engagement.

3.1 Participants and Setting

The study was conducted with 36 secondary school students (ages 14–18) from several classrooms at Shepaug Valley High School in Washington, Connecticut. Participants were selected based on teacher willingness, age appropriateness, and representation of a typical general education classroom. The sample included a balanced gender distribution and students with a range of educational needs, including those with 504 Plans and Individualized Education Programs (IEPs), allowing for the evaluation of accessibility and inclusivity.

High school students were chosen based on the readability level of the primary learning material, the WEF's AI Transformation Map. A Flesch-Kincaid Reading Ease score of 46.62 indicated college-level complexity. According to academic readability benchmarks (Yeung et al. 2018), this score corresponds to lower college-level reading complexity, making it challenging yet accessible for high school students. Moraine Park Technical College (2021) classifies such scores within the range of 30–50 as suitable for college-level content, as indicated in Table 1, reinforcing the appropriateness of the chosen age group when paired with adequate instructional scaffolding.

The inclusion of narrative scaffolding through the serious game format, supported by a NPC functioning as a MKO, was instrumental in mitigating potential cognitive overload. This design decision ensured that all learners, regardless of background, could meaningfully engage with the complex systems thinking content. Therefore, the selected participant profile supported the study's goal of evaluating the intervention's effectiveness in a realistic, inclusive high school setting.

Table 1. Adapted from Moraine Park Technical College, 2021. "What Flesch Reading Ease score should my content have?"

Flesch Reading Ease Score	School Level (U.S.)
>50	High School Level or Below
30–50	College Level
<30	College Graduate Level

3.2 Study Design

Participants played an interactive narrative game developed as a serious learning experience grounded in the Context–Learning–Game (CLG) framework [29]. The narrative was situated within a fictional corporate setting debating the integration of AI, framed through three distinct stakeholder roles: Naomi (CEO), Noel (Employee), and Daniel (Consumer). Learners assumed the role of a mediator and were guided, when needed, by an NPC named Dhwani, who functioned as a MKO. Her interventions were designed to direct players to relevant content in the AI Transformation Map, as the information dense maps are outside of the ZPD.

Gameplay involved structured stakeholder dialogues built using the Track Switching Choice structure, enabling learners to shift perspectives among the characters. The goal was to promote systems thinking by cultivating learners' ability to identify distinctions, systemic elements, interrelationships, and adopt multiple perspectives, as articulated in the DSRP framework [10]. These Learning Objectives were embedded throughout the gameplay experience, which involved repeated interactions with the Transformation Map and structured stakeholder dialogues. Specific student learning objectives were used to guide the experiment and artefact design. These were that students will be able to:

(1) apply systems thinking (DSRP) to interpret and synthesize stakeholder viewpoints within a complex decision-making scenario.
(2) construct new mental models of complex systems by engaging with digital tools (WEF's Transformation Maps)
(3) build understating of diverse ideological viewpoints
(4) explore diverse ideological positions by engaging in perspective-taking and demonstrating openness to revising one's stance based on new insights.

3.3 Instruments and Measures

Playthrough data served as a primary quantitative measure, capturing behavioral interactions during gameplay, including the number of perspective switches and the frequency with which learners accessed the MKO character. These metrics were used to explore patterns of engagement and their relationship to learners' ideological flexibility and systems understanding (see Table 2).

To ensure consistency, each session was structured into clearly defined phases and lasted approximately 80 min in total. All sessions were facilitated by the principal investigator and followed the same overall structure: an exploration phase using educational

Table 2. Outline of the survey and behavioral measures used in the study

Measure	Measurement Tool/Source	Evaluation Purpose	Measurement Purpose
Engagement Behavior	Game Logs	Analyze interaction depth and style during gameplay	Reveal depth and style of interaction during gameplay
Perspective-Taking Behavior	Game Logs	Evaluate flexibility in exploring multiple viewpoints and stakeholder roles	Track perspective-shifting across stakeholder roles
User Experience	Post-Test Likert Questions	Assess usability, preference, and confidence in the learning modality	Gauge engagement, preference and impact of learning modality

IDN with embedded transformation maps, a written recommendation task in which students proposed an ethical AI integration strategy that satisfied multiple stakeholders, and a post-test questionnaire to evaluate overall experience, usability, and preference. This structured flow ensured parity in time and task structure across all classes, enabling valid comparison of their learning outcomes.

Post-Tests. Students completed a post-test questionnaire immediately after participation with the narrative game and transformation maps. The post-test measured user experience, specifically engagement and format preferences. These responses were used to evaluate the acceptability of the game design and whether or not narrative-driven systems learning in formal educational settings is preferred.

Perspective Switching Logs. Logs were generated that tracked player navigation across stakeholder dialogue branches. Every transition from one stakeholder's viewpoint to another was logged, enabling researchers to quantify switching behavior. These logs captured each transition between stakeholder perspectives, enabling analysis of player preferences and spontaneous engagement with divergent viewpoints. Importantly, perspective choices were anonymized to avoid priming or biasing learners, allowing for the unobtrusive measurement of ideological flexibility based on behavioral patterns alone. The combination of behavioral data and written reflection provided a rich measure of ideological flexibility and epistemic curiosity.

NPC MKO Engagement Metrics. All interactions with Dhwani, the MKO character, were recorded. These included the number of times learners sought her guidance and compared that to overall perspective shifts and final perspective stance.

Quantitative data from the post-test and behavioral logs were analyzed using paired t-tests and correlation analysis to identify significant changes and relationships.

4 Game Design and Implementation

The development of the serious game in this study was guided by the Context–Learning–Game (CLG) Framework, as defined in the doctoral thesis by Rojas-Salazar [29, 30]. The CLG Framework offers a structured and theoretically grounded approach to designing educational games by aligning three interdependent components: the context, learning, and game stages. The 'Context' stage defines the educational setting and learner profile. The 'Learning' stage specifies the pedagogical goals and desired competencies. The 'Game' stage describes the mechanics, narrative elements, and interactive structures that deliver the learning experience. This triadic alignment ensures the game remains anchored in real-world relevance, educational objectives, and interactive engagement.

The design of the educational artifact was informed by the contextual parameters outlined in Sect. 3: Experimental Design Methodology. This experimental design phase defined the learner profile, classroom environment, technological constraints, and targeted systems thinking objectives, factors that directly informed the artifact's development. In alignment with the CLG framework, articulating the "Context" first ensured that the narrative and pedagogical features of the artifact were purposefully designed to meet the specific needs and conditions of the learning environment. This approach allowed the artifact to be both educationally relevant and practically deployable, grounded in the realities of the classroom setting and the characteristics of its users.

To operationalize the narrative structure, the game was authored using *Ink*, an open-source scripting language developed by Inkle Studios for crafting nonlinear, branching narratives. To simulate a realistic and immersive communication environment, additional presentation code was developed to render the narrative as a group chat interface (see Figs. 3 and 4). This format allowed learners to engage with multiple non-player characters (NPCs) representing diverse stakeholder perspectives, supporting intuitive perspective-taking and track switching.

In this study, the context centres on high school students engaging with the complex issue of artificial intelligence (AI) integration in business using the WEF's Strategic Intelligence Transformation Maps. The learning stage emphasizes the development of DSRP systems thinking competencies within complex systems. These skills are developed through structured engagement with the Transformation Maps, which serve as both content and systems thinking tools. Although the DSRP framework is not explicitly introduced to learners, its core principles are intentionally embedded in the game design to scaffold and reinforce systemic reasoning.

The game stage employs a narrative-based interactive digital format that presents learners with role-based scenarios involving diverse stakeholders in the AI ecosystem. Through engagement with a MKO character, learners are guided to explore multiple perspectives. This approach mitigates common challenges associated with navigating the Transformation Maps, such as information overload and lack of guidance, by embedding structured prompts within a narrative flow [5]. The narrative thus serves not merely as a storytelling device but as a cognitive scaffold that supports exploration, comprehension, and application of complex systems thinking.

The adoption of the CLG Framework enabled the coherent integration of educational theory, systems thinking pedagogy, and game design to develop a serious game tailored

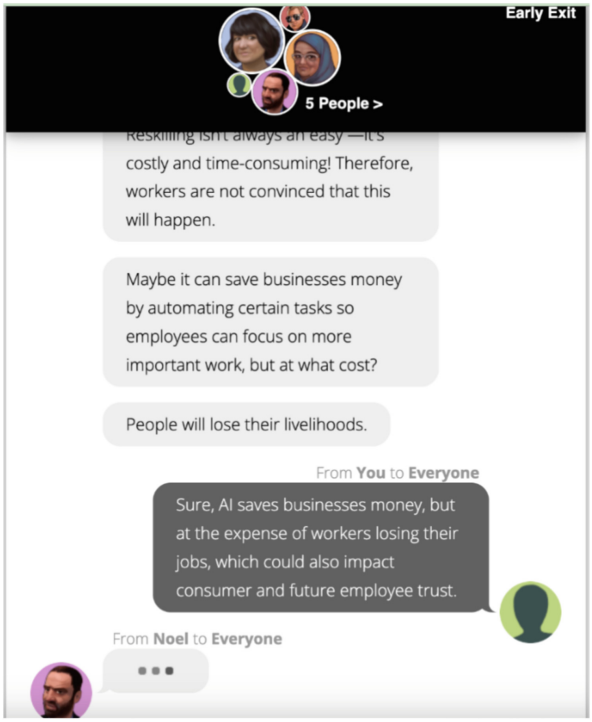

Fig. 3. Simulated group chat interface showing NPC dialogue branches (Noel, the employee in this case). The interface was implemented using JavaScript to parse Ink output into styled message bubbles and to simulate the temporal dynamics of real-time messaging, such as delayed message arrival and "typing" indicators.

to the cognitive and contextual needs of high school learners addressing complex global topics such as AI integration in society.

4.1 Stakeholder Character Design

Three central stakeholder characters were created, each representing a different position in the debate on AI as reflected in the Transformation Maps (see Table 3). These characters were designed to surface ideological tensions and systemic interdependencies, helping learners explore the complex trade-offs associated with AI integration. By representing distinct roles, CEO (Naomi), employee (Noel), and customer (Daniel), each character offered a different lens through which to evaluate systemic impacts and stakeholder priorities.

The characters' dialogues were modular and structured into branching scenes, enabling learners to switch perspectives and uncover new information relevant to the decision-making scenario. Dialogue paths were embedded with cues aligned to systems thinking constructs such as distinctions and relationships, helping students identify the dynamics underlying each stakeholder's position. These structures promoted exploration, encouraging learners to revisit prior assumptions and refine their mental models based on new insights.

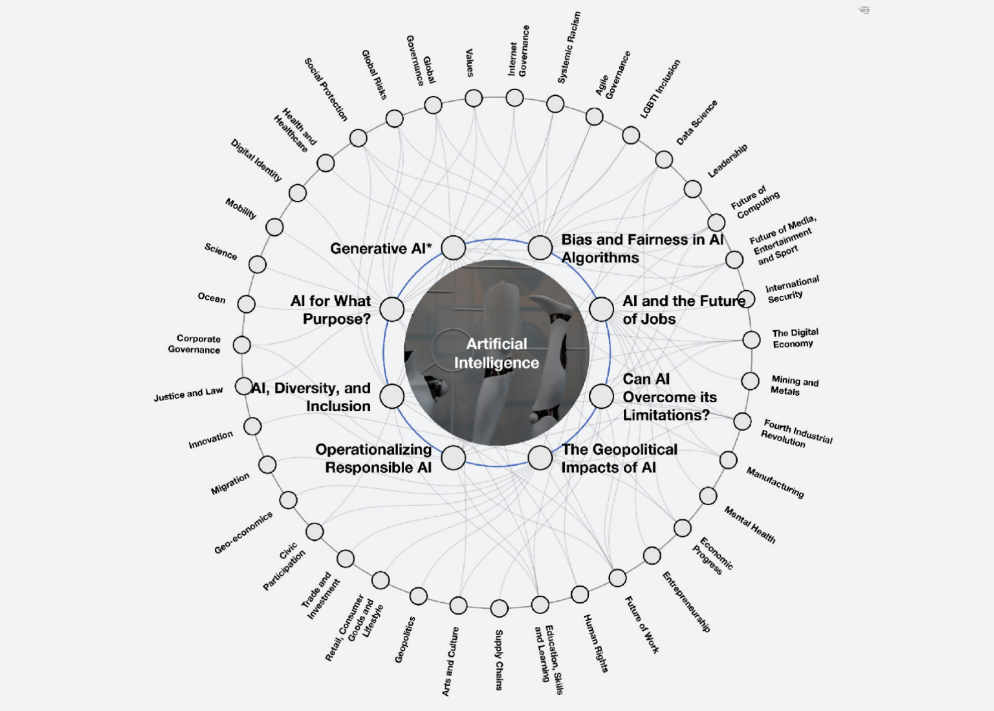

Fig. 4. The AI Transformation Map computer interface, where students receive prompts from Dhwani, the More Knowledgeable Other (MKO), guiding them to relevant content. Students can also freely explore key issues within the map, depending on the conversation path they are navigating on their mobile device.

Table 3. Stakeholder Roles, Perspectives, and Narrative Functions

Character Name	Stakeholder Role	Perspective
Naomi	Chief Executive Officer (CEO)	Supports AI adoption to improve efficiency, profitability, and staying competitive; stance considered pro-AI.
Noel	Mid-level Employee	Raises concerns about job displacement and ethical implications; stance considered anti-AI.
Daniel	Customer	Prioritizes affordability and efficiency but expresses concerns about ethics, service, and privacy; stance considered centrist.

4.2 Track Switching Choice Structure Integration

Emily Short's Track Switching Choice structure was employed to create structurally distinct yet interconnected narrative threads. Players could move laterally between stakeholder dialogues at key decision points, simulating a shift in narrative perspective without being confined to a linear path. These switches were recorded and analyzed as markers

of perspective-switching, allowing researchers to examine how exposure to alternative views influenced player trajectories and encouraged ideological flexibility.

Each switch allowed players to choose from three options without being informed which character each option represented. This structure was intentionally designed to reduce priming effects and bias by anonymizing dialogue choices. By withholding character identity, the system encouraged learners to engage with arguments based on their content rather than on preconceptions tied to specific stakeholders. This approach provided a more authentic behavioral measure of ideological flexibility, capturing how learners aligned with different perspectives without metacognitive cues or guiding signals.

This novel adaptation of the Track Switching Choice structure transformed a narrative design concept into a research instrument, enabling the study of learner agency, epistemic curiosity, and the iterative construction of understanding. In later sections of the game, players were encouraged to synthesize insights from multiple tracks when constructing final policy recommendations, highlighting how narrative structure and learning objectives were tightly interwoven.

4.3 Role of the MKO

A central feature of the IDN was Dhwani, a narrative character designed as a non-intrusive MKO. The purpose was to enable learners with varying levels of ability and skills, both higher and lower, the opportunity to explore the complex system in line with their own abilities and not be forced to interact unless needed, a term commonly used in U.S. education known as differentiation [31]. Unlike tutorial guides or narrators, Dhwani was cast as a colleague within the fictional organization. Players could consult her at any point for help from navigating the Transformation Map to contextualizing stakeholder arguments.

Dhwani's responses were designed using principles of minimal guidance: rather than supplying answers, she directed players toward specific sections of the AI Transformation Map. Her character encouraged exploration and self-regulated learning, positioning her as a dynamic resource rather than an authority figure.

The inclusion of Dhwani as a narrative scaffold draws from findings in an earlier ICIDS paper, "Integrating Narrative Design into the World Economic Forum's Transformation Maps for Enhanced Complexity Comprehension in Interactive Storytelling" [5], which identified that learners found the WEF's Transformation Maps cognitively overwhelming in isolation. The study suggested that the maps fell outside most users' ZPD, calling for narrative scaffolding to improve accessibility and engagement. In this project, rather than relying solely on the maps as standalone tools, we incorporated them into a narrative game format and embedded Dhwani as an NPC to serve as a MKO. This approach transforms the Transformation Maps from static data tools into interactive, learner-centered experiences, enabling more intuitive exploration and systems-level reflection.

Importantly, Dhwani's role bridges two complementary learning theories: Vygotsky's ZPD and Metcalfe et al.'s RPL [28]. While ZPD focuses on external guidance enabling learners to complete tasks beyond their independent capacity, RPL emphasizes internal metacognitive awareness that learners are nearing conceptual insight. Dhwani

supports both processes—she provides structured scaffolding to assist comprehension (ZPD), while her prompts are crafted to activate learners' intrinsic curiosity and reflection (RPL). This dual alignment strengthens the narrative's pedagogical impact by facilitating both guided exploration and autonomous meaning-making.

Building on this dual scaffolding role, the game's constructivist design allowed learners to build understanding through iterative interaction and contextual decision-making. This MKO reinforces the narrative's capacity not only to guide, but to provoke curiosity, modeling effective support in complexity learning.

5 Results

5.1 User Experience and Perceived Learning Gains

Students reported high levels of engagement, self-confidence, and preference with the activity (see Table 4). The post-activity survey revealed that 91.7% of students agreed or strongly agreed that they felt capable of completing this activity (M = 6.31) (see Fig. 5), yet only 52.8% (M = 5.22) felt that the maps alone helped them understand the complexity (see Fig. 6). This suggests that while the Transformation Maps contained rich systems content, additional support was needed to foster deeper understanding. Also, the majority of students found the activity engaging and would prefer activities like this to regular class work (see Figs. 7 and 8). The narrative scaffolding, particularly the integration of stakeholder dialogues and the MKO character Dhwani, likely played a critical role in helping learners interpret, contextualize, and engage with the complex information presented.

Table 4. User Experience Metrics

Survey Question	Mean Score
I found this activity engaging.	5.56
I prefer this type of learning experience (game/platform).	5.42
I felt capable of completing the activity.	6.31
The maps helped me understand AI and its complexity?	5.22

Note: Scores represent mean responses on a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree)

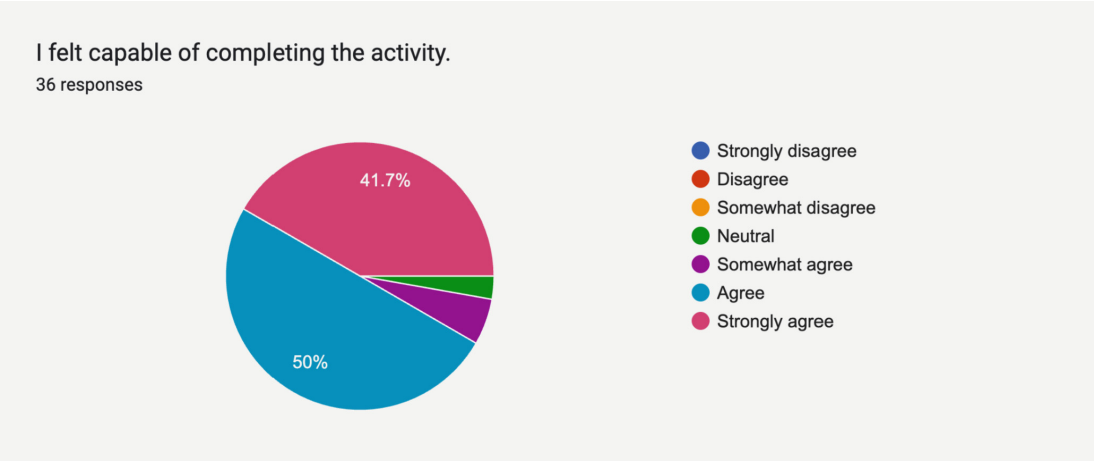

Fig. 5. A total of 91.7% of students reported feeling capable of completing the activity, and affordances of the game experience and environment positively impacted students' confidence in engaging with early college–level content.

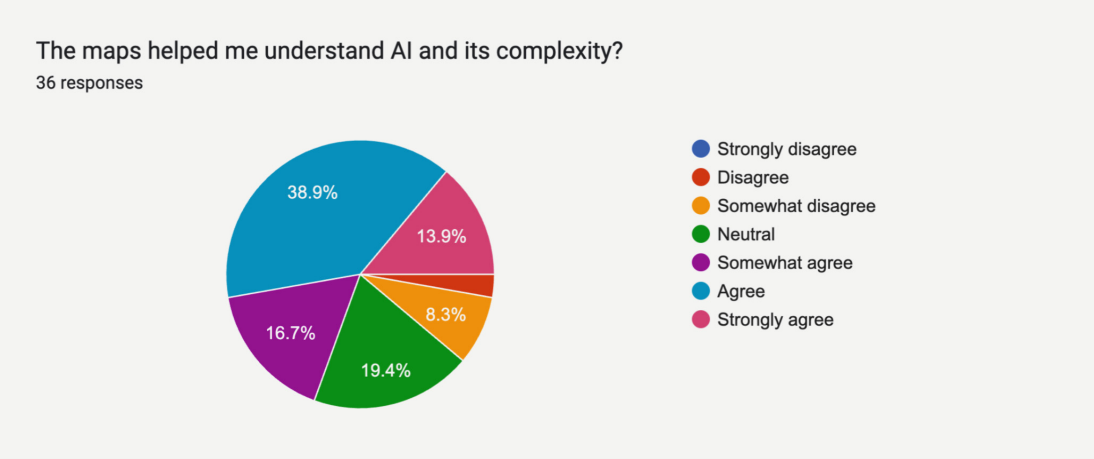

Fig. 6. Only 52.8% (M = 5.22) strongly agreed or agreed that they felt the maps helped them understand the complexity. However, only 11.1% of students showed disagreement that the maps helped them understand AI and its complexity.

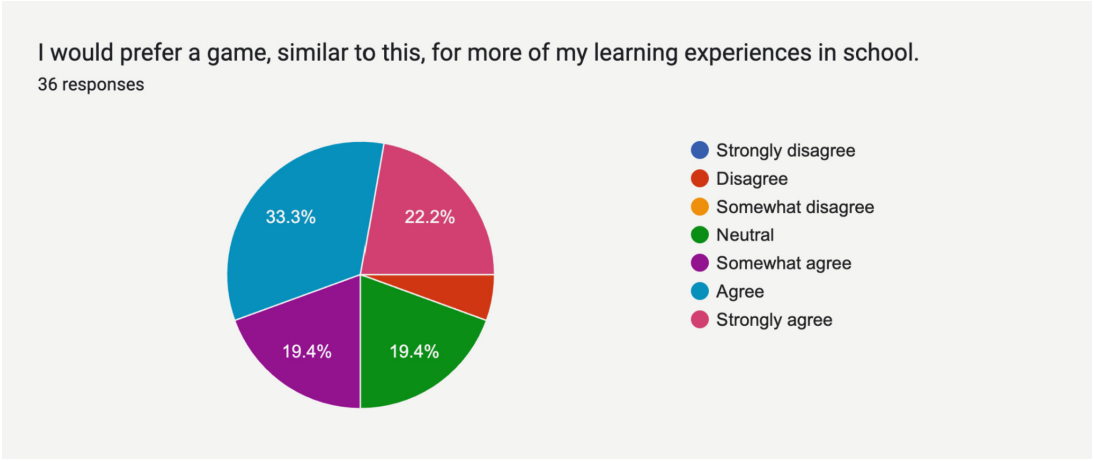

Fig. 7. Only a small minority (5.6%) did not prefer this type of game for future learning.

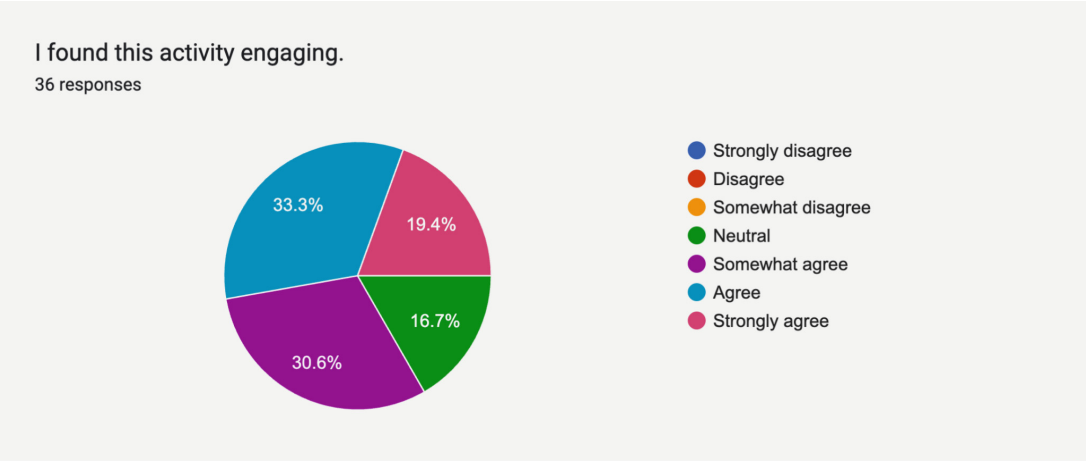

Fig. 8. A total 83.3% of students agreed that the activity was engaging, while only 16.7 were neutra. No students felt the activity was not engaging.

6 Ideological Shifts and Moderation Trends in Log-Based Behavior

To evaluate whether participants shifted positions to more or less polarized characters, gameplay alignment data were analyzed; 69.44% of students changed their character alignment, while 30.56% did not.

This character alignment was logged in the beginning and end of the game. At the beginning of the game, they initially selected a stakeholder perspective likely based on their preexisting ideological stance and the introductory statements by the characters (Fig. 9). Their final alignment was captured after engaging with all perspectives (Fig. 10).

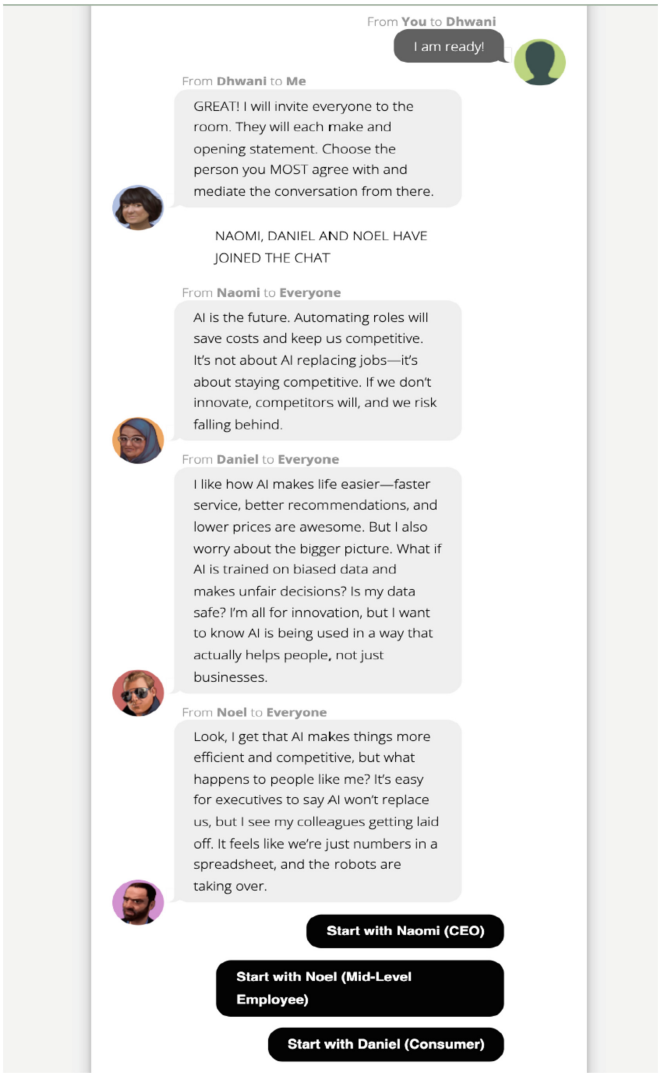

Fig. 9. Users make their initial choice which is logged in-game log.

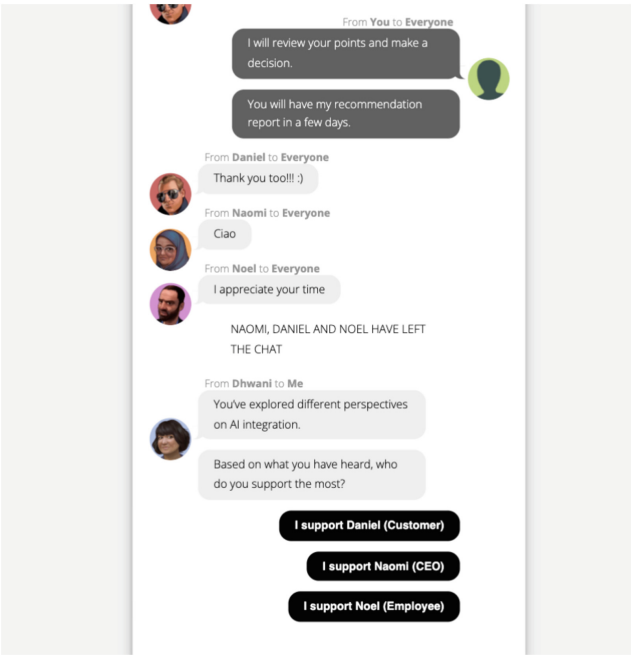

Fig. 10. Users make their final choice which is logged in the game log.

An analysis of participants' final character choices revealed a clear trend toward ideological moderation. Daniel, who represented a centrist view, emerged as the most frequent final alignment, with 12 users shifting to him from Naomi or Noel. Naomi received 7 switches, and Noel received 4, indicating significantly less attraction toward extreme stances (see Table 5).

Table 5. Character Preference Shifts (Initial → Final)

	Daniel	Naomi	Noel
Daniel	5	2	4
Naomi	6	6	0
Noel	6	5	6

Further behavioral data distinguished between two learner groups: switchers (those who changed their initial character alignment by the end of the game) and loyalists (those who maintained their original alignment). Switchers who changed character alignment spent significantly more time in the experience ($M = 1467.83$ s) compared to loyalists ($M = 1073.26$ s), a difference that was statistically significant ($p \approx 0.040$). Although switchers also exhibited more in-game perspective switches between stakeholder dialogues (5.30 vs. 4.65), this difference was not statistically significant ($p \approx 0.25$). Table 6 offers a breakdown of how learners transitioned between stakeholder perspectives throughout the game. It visualizes the alignment shifts from each initial character choice to final selection, capturing the dynamics of learner decision-making over the course of the narrative. By tracking these movements, the table highlights how exposure to multiple

perspectives facilitated reconsideration and ultimately led to more balanced ideological positions.

Table 6. Final Character Alignments and Behavioral Measures

Measure	Result
Most common final alignment	Daniel (Moderate position)
Total switches to Daniel	12
Total switches to Naomi	7
Total switches to Noel	4
Avg. time-on-task (Switchers)	1467.83 s
Avg. time-on-task (Loyalists)	1073.26 s
Time-on-task significance	$p \approx 0.040$
Avg. perspective switches (Switchers)	5.30
Avg. perspective switches (Loyalists)	4.65
Perspective switches significance	Not significant ($p \approx 0.25$)

These findings suggest that students actively reconsidered initial assumptions and moved toward more moderate, integrated viewpoints over time, reinforcing the role of narrative environments in supporting depolarization and reflective exploration.

6.1 The Role of Dhwani - The MKO

To further understand the cognitive impact of the game, this section investigates the role of Dhwani, the embedded NPC who acts as a MKO. Drawing from theoretical frameworks such as Vygotsky's ZPD and Metcalfe's RPL, Dhwani was designed not merely as a narrative device, but as a scaffold to support learners' reflection and engagement with complex systems. The findings in this section are organized around three key observations: (1) engagement with Dhwani predicts final perspective shifting, (2) narrative engagement followed a learner-driven, non-linear trajectory marked by emergent inflection points, and (3) Dhwani8, a specific prompt within the narrative, functioned as a cognitive inflection point correlated with ideological flexibility. These findings are derived exclusively from gameplay log data and reveal distinct learner behaviors that illustrate how narrative scaffolding can support reflective exploration and perspective transformation.

Engagement with Dhwani Predicts Final Perspective Shifting. Game log data showed that approximately 70% of students who interacted with Dhwani's prompts changed their final character alignment, compared to only 35% of those who did not. This suggests Dhwani functioned effectively as an epistemic scaffold, promoting deeper perspective-taking and ideological flexibility (see Table 7).

Logistic regression analysis confirmed a statistically significant relationship between Dhwani engagement and character switching ($p = .038$). Learners who accessed any

Dhwani-tagged content were substantially more likely to revise their final perspective, reinforcing the role of narrative scaffolding in facilitating epistemic exploration.

Table 7. Dhwani Use and Switching Behavior

Dhwani Use	% Switched	% Stayed
Used Dhwani	~ 70%	~ 30%
Did Not Use	~ 35%	~ 65%

These results support the hypothesis that Dhwani's reflective prompts acted as epistemic scaffolds, facilitating deeper reconsideration of perspectives and encouraging narrative exploration beyond initial ideological positions.

Learner-Driven Narrative Engagement and Emergent Inflection Points. An analysis of tag usage over the course of the narrative experience revealed that Dhwani's influence did not follow a typical early-to-late decay pattern, as is often observed in digital narratives where player attention to novel items tends to decay over time, following a stretched-exponential law [32]. Instead, engagement with Dhwani appeared path-dependent, shaped by the individualized meaning-making processes and narrative choices of each learner (See Fig. 11).

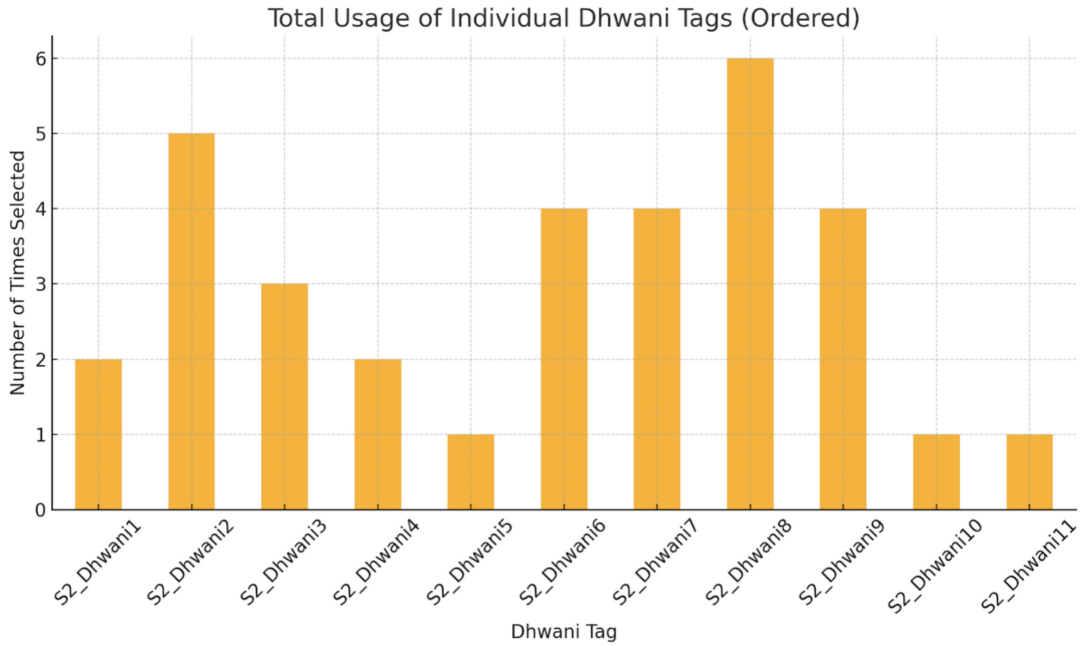

Fig. 11. Graph showing the total usage of individual dhwani tags chronologically throughout the game, highlighting an atypical peak later in the game with the Dhwani8 tag.

Specifically, early tags like Dhwani2 saw consistently high engagement, suggesting that learners were initially receptive to reflective input. Mid-sequence tags (Dhwani5–7, 9–11) displayed variable usage, likely reflecting the branching and adaptive nature of

the narrative system, which allowed players to move through different content paths depending on prior decisions.

Dhwani8 emerged as the peak point of engagement, surpassing all other tags—even though it occurred later in the narrative arc and lacked system-driven emphasis. This challenges conventional assumptions about cognitive load or engagement decay in digital learning environments. Instead, it implies that narrative and ideological tension may have organically culminated at this point, drawing learners into a moment of deeper reflection.

What this shows is that Dhwani2–4 had high early engagement, particularly with Dhwani2. Dhwani5–7, 9–11 had variable usage, and Dhwani8 had Peak usage across all tags.

The combination of high early engagement, non-linear mid-game usage, and a late-game spike may suggest a learner-driven trajectory in which players engaged with Dhwani not out of scripted necessity, but in response to emerging cognitive needs and moments of narrative dissonance.

Dhwani8: An Emergent Cognitive Inflection Point. Among all Dhwani-tagged interactions, Dhwani8 had the highest engagement rate and showed a strong correlation with ideological switching (83.3%) (Table 8). Players who accessed Dhwani8 were more likely to change their final alignment and demonstrated broader engagement with multiple stakeholder perspectives. Despite no changes in narrative prompt or interface cues, this moment drew more learners than any other point in the game.

Table 8. Comparison of users who did and did not engage with Dhwani8 revealed a distinct pattern

Metric	Did NOT Use Dhwani8	Used Dhwani8
Switch Rate	52.9%	83.3%
Daniel Tags Accessed	3.18	4.00
Noel Tags Accessed	2.74	3.17
Naomi Tags Accessed	3.09	1.83 ↓

This suggests Dhwani8 may have functioned as a critical inflection point—what some scholars refer to as an epistemic change [33], or a shift in how individuals understand and engage with knowledge. Despite no change in narrative prompt or system cue, learners frequently paused at this point to reflect and reconsider their stance. This behavior aligns with Sect. 2.4's discussion of learner-initiated engagement, illustrating how well-timed narrative scaffolds can support ideological flexibility. While the study does not fully explore the long-term effects of such moments, the findings point to promising directions for future research on how emergent narrative prompts can foster perspective transformation and ideological flexibility.

7 Discussion

7.1 Advancing the Role of IDNs in Education

This study demonstrates that IDNs can serve not only as engaging pedagogical tools but also as platforms for measuring behavioral indicators of learning. The use of Emily Short's Track Switching Choice structure allowed for the logging of perspective-switching behavior, providing a unique window into learners' mind as they engaged with multiple stakeholder positions.

Importantly, the results indicate that narrative structures supporting non-linear exploration can encourage learners to challenge their initial assumptions, a critical step toward reducing ideological rigidity. This suggests that IDNs are well-suited to addressing educational goals related to civic discourse, empathy, and critical thinking.

7.2 The Value of a Narrative-Driven MKO

This design was directly informed by prior research identifying that learners found the Transformation Maps overwhelming when unaided, necessitating narrative scaffolding to improve engagement and understanding [5]. The inclusion of Dhwani as a MKO represents a novel approach to scaffolding within IDNs. Rather than functioning as a didactic guide or linear tutor, Dhwani's role was as a support in navigating the complexity of the map interface. It is suggested that her omniscient presence, though she never interfered unless called upon, acted as a comfort to students, making them feel capable of completing the activity.

Interaction with Dhwani prompts, particularly Dhwani8, correlated with greater ideological movement between characters. This suggests a relationship between engagement with reflective content and increased ideological flexibility within the narrative experience. The broader analysis of playthrough data revealed meaningful patterns of cognitive engagement tied to time-on-task, perspective switching, ideological moderation, and interaction with epistemic scaffolds. Students who spent approximately 25–30 min in the experience demonstrated the deepest levels of narrative exploration and were more likely to shift perspectives and adopt moderate ideological positions.

Central to this process was the role of Dhwani, who served as a scaffold for self-directed reflection. Learners appeared to recognize moments of uncertainty or conceptual conflict and autonomously engaged with her prompts—especially Dhwani8—which emerged as a metacognitive checkpoint. This behavior underscores the capacity of reflective narrative elements to prompt voluntary cognitive reappraisal. Overall, these findings support the view that well-designed narrative systems can facilitate depolarization, encourage systems thinking, and promote sustained cognitive engagement. They also highlight the potential of interactive storytelling to foster critical thinking and ethical reasoning in complex, real-world domains such as artificial intelligence and societal risk.

7.3 Design Implications for IDNs and Systems Pedagogy

The alignment of narrative games with systems thinking constructs, particularly the DSRP model, provided a framework for translating abstract systems principles into

actionable in-game choices and dialogue. This design approach aligns with established findings in serious game literature, which emphasize the pedagogical value of developing knowledge through interaction and exploration with appropriate scaffolding rather than direct instruction [34]. Instead of isolating learning in external explanations, effective games integrate instruction within gameplay itself, fostering "situated meaning" - the idea that knowledge is best acquired through interactive, contextualized practice. In this study, narrative scaffolds were embedded into the role-based design, perspective-switching mechanics, modular NPC support, and the dynamic visualizations of the transformation maps, encouraging learners to engage more deeply with complexity and demonstrate greater ideological flexibility.

Future IDNs aiming to cultivate systems thinking would benefit from integrating these design strategies. Carefully aligning systems thinking skills into the narrative, allowing learner-driven exploration, and structuring interactions around contrasting stakeholder perspectives can support both metacognitive development and conceptual change, especially when paired with a narrative scaffold like the MKO that supports self-directed learning in line with ZPD and RPL principles.

7.4 Limitations and Future Work

This study is subject to several limitations. The intervention was relatively short and conducted in a specific educational context, which may limit generalizability. The participant pool was relatively small ($n = 36$), and future studies would benefit from a larger and more diverse sample to improve generalizability and statistical power. The measurement of ideological flexibility was indirect, behavioral proxies rather than long-term tracking of belief change.

Future work should examine the longitudinal impact of IDN-based systems learning on ideological development. Additionally, the design of adaptive MKO characters capable of tailoring feedback to user profiles may further enhance the personalization and efficacy of narrative scaffolding. Exploring other domains, such as climate change or public health, could also test the transferability of the design framework.

Although the study was designed to promote ideological flexibility, the data collected primarily capture short-term behavioral and reflective indicators of ideological flexibility. Longitudinal studies would be necessary to measure durable shifts in belief systems or ideological stance.

8 Conclusion

This study explored how IDNs can support ideological flexibility and systems thinking by enabling learners to engage with diverse perspectives in a complex decision-making context. Through the design and implementation of an educational IDN grounded in the CLG framework, the research addressed the central question of how IDNs can be used to measure the impact of exposure to multiple perspectives on learners' ideological flexibility.

Findings from both behavioral logs and self-reported experiences suggest that the integration of Emily Short's Track Switching Choice structure (SRQ2) successfully facilitated perspective-switching, providing measurable insights into how learners navigated

ideological complexity. Moreover, the inclusion of a MKO character (SRQ3) functioned as a non-intrusive scaffold that enhanced learner agency and supported systems-level reasoning. Finally, the narrative game exposed players to competing stakeholder viewpoints within a single, immersive experience, promoting the core dimensions of systems thinking—particularly the recognition of dynamic interactions and multiple viewpoints (SRQ1).

By transforming abstract systems concepts into situated, narrative-based interactions, this study demonstrates that IDNs can function not only as educational tools but also as analytic frameworks for examining learner behavior. The findings offer promising implications for future research and practice, particularly in designing digital environments that cultivate cognitive adaptability and epistemic curiosity in the face of complex, real-world challenges.

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