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Research Article

From Story to Strategy: An Action Research on the Effects of Narrative-Based Notebook Games on High School Students' Mathematical Engagement and Problem-Solving Skills

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Abstract

This action research study investigates the effects of narrative-based interactive notebook games on high school students' mathematical engagement and problem-solving skills. Action research, as an inquiry methodology, enables practitioner-researchers to systematically examine and improve their own pedagogical practice through iterative cycles of planning, action, observation, and reflection. A convergent mixed-methods design was employed with 24 students (Grades 9–10, ages 14–16) over a three-week classroom intervention aligned with the Turkish national mathematics curriculum. Quantitative data were collected using a pre-test/post-test problem-solving assessment and a 12-item student engagement scale (Cronbach's $\alpha = .87$), while qualitative data were obtained through student reflective journals and structured classroom observations. Results indicate statistically significant improvements in both engagement ($t(23) = 5.87$, $p < .001$, $d = 0.68$) and problem-solving performance ($t(23) = 4.12$, $p < .001$, $d = 0.72$), with large effect sizes in both cases. Three qualitative themes emerged: persistence under difficulty, emotional engagement with the narrative, and emergent strategic thinking. The study demonstrates that narrative-integrated game structures can serve as a pedagogically effective, low-cost, and scalable tool in secondary mathematics education, requiring no digital infrastructure while producing meaningful gains in both effective and cognitive outcomes.

Keywords: Mathematics education, action research, narrative-based learning, game-based learning, student engagement, problem-solving skills.

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INTRODUCTION

Despite decades of curriculum reform, a persistent challenge in secondary mathematics education remains the disconnect students perceive between formal mathematical procedures and meaningful real-world application. High school students frequently report low intrinsic motivation, mathematics anxiety, and a belief that the subject lacks personal relevance (Hannula, 2002; Middleton & Spanias, 1999). This affective dimension of mathematics learning has been identified as a critical determinant of both sustained engagement and long-term academic achievement (Hidi & Renninger, 2006). In the Turkish educational context, national assessments consistently document low mathematics motivation among secondary students, a pattern that the standard curriculum structure has not yet adequately addressed (MEB, 2018).

Two instructional approaches that have gained considerable scholarly attention in response to this challenge are game-based learning and narrative-based instruction. Game-based learning environments have been shown to increase motivation, foster productive persistence in the face of difficulty, and promote strategic thinking (Gee, 2003; Plass et al., 2015; Prensky, 2001). Simultaneously, narrative structures — the use of story, character, conflict, and resolution as pedagogical scaffolding — have been identified as powerful tools for meaning-making, contextualization, and emotional engagement with content (Bruner, 1991; Egan, 1986). However, most implemented forms of these approaches in mathematics classrooms rely on digital technologies, which may present barriers related to cost, institutional access, and infrastructure, particularly in public school settings.

This study addresses the intersection of these two approaches through the design and implementation of narrative-based notebook games — pen-and-paper, story-driven problem-solving activities embedded within a structured game format. Unlike digitally mediated game environments, these activities require no technological infrastructure and are thus immediately scalable across diverse classroom contexts. The notebook game format places students within a narrative scenario (e.g., escaping a time loop, decoding a mystery) while requiring them to solve curriculum-aligned mathematical problems in order to progress the story.

The study employs action research as its overarching methodology. Action research is a form of practitioner-led, cyclical inquiry in which teachers systematically investigate their own classroom practice with the aim of improving educational outcomes (Carr & Kemmis, 1986; Kemmis & McTaggart, 1988). Unlike traditional experimental research, action research is conducted within the natural setting of the classroom and is characterized by iterative cycles of planning, acting, observing, and reflecting (McNiff, 2013; Stringer, 2014). This methodology is particularly well-suited to the present investigation because it allows the researcher, who is simultaneously the classroom teacher, to examine instructional innovations in an authentic and contextually grounded manner, generating knowledge that is both theoretically informed and immediately applicable to practice.

The present study was conducted at a Turkish state high school and was guided by the following research question: *How do narrative-based notebook games affect high school students' mathematical engagement and problem-solving skills?*

LITERATURE REVIEW

Game-Based Learning in Mathematics Education

Game-based learning (GBL) has been an area of sustained empirical and theoretical interest in mathematics education over the past two decades. Gee (2003) established a foundational theoretical argument that well-designed games embody sound learning principles — including incremental

challenge, immediate feedback, and identity investment — that align closely with what cognitive science identifies as effective for deep learning. Subsequent empirical studies have broadly supported this claim. Plass et al. (2015) conducted a systematic review of GBL research and concluded that games produced significant learning gains when game mechanics were directly integrated with instructional content, rather than used as extrinsic reward systems layered over conventional instruction.

More recent studies have extended this work to secondary mathematics contexts. Lamb et al. (2018) found that game-based algebra activities significantly improved both procedural fluency and conceptual understanding among Grade 8 students compared to textbook instruction. Hanus and Fox (2015) introduced an important cautionary note, however, demonstrating that superficial gamification — the addition of points, badges, and leaderboards to non-game content — could undermine intrinsic motivation when students perceived game elements as controlling rather than autonomy-supportive. This distinction between deep game-based learning and surface-level gamification is central to the design philosophy of the present study, which integrates narrative and mathematical challenge at the structural level rather than adding game elements as post-hoc motivational overlays.

In the Turkish secondary education context, research on GBL in mathematics remains relatively limited but is growing. Çakıroğlu et al. (2019) reported positive effects of digital game-based activities on Grade 7 students' algebra achievement and mathematics attitudes, while noting that implementation barriers related to technological access constrained scalability. The present study directly addresses this scalability constraint by employing a fully analogue format.

Narrative-Based Learning and Mathematics

The use of narrative as a pedagogical scaffold in mathematics education draws on a rich tradition in both cognitive psychology and educational theory. Bruner (1991) distinguished between the paradigmatic mode of thought — characterized by logical, abstract reasoning — and the narrative mode, which organizes experience through story, character, and temporal sequence. He argued that human beings are fundamentally narrative creatures and that learning is most durable when embedded in meaningful story structures that give abstract content a human and purposive context.

Egan (1986, 1989) extended this insight into a practical pedagogical framework, arguing that all effective teaching can be understood as a form of storytelling. He proposed that lessons structured around narrative elements — particularly the binary tension between opposing forces (safety/danger, known/unknown, order/chaos) — engage students' imaginations in ways that conventional expository teaching cannot. In mathematics education, Zazkis and Liljedahl (2009) demonstrated that story-based problem contexts substantially increased students' willingness to engage with and persist through challenging mathematical tasks. More recent work by Rowe et al. (2017) found that narrative-embedded mathematics games produced stronger learning outcomes than equivalent non-narrative game formats, suggesting that the story context functions as more than mere motivational decoration — it actively structures the cognitive experience of problem-solving.

The present study builds on these findings by examining whether similar effects can be achieved through entirely paper-based narrative game materials, thereby removing digital access as a prerequisite for this form of instruction.

Student Engagement in Secondary Mathematics

Student engagement is a multi-dimensional construct encompassing behavioral, cognitive, and emotional components (Fredricks et al., 2004; Skinner et al., 2009). In mathematics education, disengagement — characterized by passive compliance, avoidance behaviors, and emotional withdrawal

— is a well-documented phenomenon at the secondary level (Attard, 2013). Hannula (2002) identified attitudes towards mathematics as one of the strongest predictors of both engagement and achievement, arguing that affective experiences in mathematics classrooms accumulate into relatively stable belief systems about the subject and the self.

Intervention studies targeting mathematics engagement have demonstrated that instructional approaches emphasizing relevance, autonomy, and challenge are consistently more effective than conventional direct instruction in sustaining student motivation (Middleton & Spanias, 1999; Stipek et al., 1998). Narrative-based and game-based approaches are theoretically aligned with all three of these engagement-promoting features: they provide contextual relevance through story, foster autonomy through student choice and agency within the game, and calibrate challenge through the incremental structure of game levels and narrative episodes.

Theoretical Framework

This study draws on three intersecting theoretical traditions. First, Hidi and Renninger's (2006) Four-Phase Model of Interest Development provides a framework for understanding how situational interest — triggered by novelty, narrative, or surprise — can be transformed into sustained individual interest through repeated meaningful engagement. The narrative notebook game format is theorized as an interest-triggering mechanism that capitalizes on students' natural affinity for story and structured play, with the intention of gradually cultivating deeper mathematical curiosity.

Second, Bruner's (1991) narrative mode of thought posits that human cognition operates in two fundamental modes: paradigmatic (logical, abstract, propositional) and narrative (contextual, temporal, meaning-centered). Mathematics instruction predominantly privileges paradigmatic mode; narrative-based activities offer a complementary entry point that renders abstract content accessible through contextualized, story-driven structures. This theoretical lens suggests that narrative scaffolding may reduce the perceived cognitive distance between students and formal mathematical concepts by providing a human, purposive frame for otherwise decontextualized procedures.

Third, Polya's (1945) heuristic model of problem-solving — comprising the phases of understanding the problem, devising a plan, carrying out the plan, and looking back — underpins the structural design of the notebook game tasks. Each narrative scenario was deliberately constructed to make these problem-solving phases explicit and visible to students, encouraging them to articulate their reasoning and reflect on their strategic choices rather than simply executing computational procedures.

Design and Implementation of the Activity

The narrative-based notebook game activities were designed in alignment with the Turkish National Mathematics Curriculum (MEB, 2018) for Grades 9 and 10, specifically targeting learning outcomes related to linear equations, systems of equations, and proportional reasoning. Each game session was contained within a custom-designed A4 booklet — hereafter referred to as the "game notebook" — that student retained across the duration of the intervention. The booklets integrated story text, mathematical task prompts, branching choice points, and structured reflection prompts at the close of each session.

The game structure followed a three-act narrative arc across each episode: (1) an inciting incident that established the story world and presented an initial mathematical challenge, framed as a problem the protagonist needed to solve to survive or advance; (2) a rising action phase requiring progressively more complex problem-solving, with student choices affecting the direction of the narrative; and (3) a resolution phase in which students reflected on their strategies, evaluated the outcomes of their decisions, and completed a brief written journal entry. Each session lasted 40–45 minutes. All materials

were exclusively paper-based, including the game notebooks, annotation space for working, and a classroom "hint card" system. Hint cards could be requested once per challenge and provided a scaffold for metacognitive strategy selection without revealing the solution directly.

The implementation unfolded over three weeks as follows. In Week 1, students completed the pre-test problem-solving assessment and the engagement scale, received an orientation to game mechanics and narrative structure, and participated in Episode 1 ("The Time Loop"), centered on solving linear equations. In Week 2, Episodes 2 ("The Cipher Map", targeting systems of equations) and 3 ("The Merchant's Dilemma", targeting proportional reasoning) were implemented across two class sessions. In Week 3, students completed the culminating Episode 4 ("The Final Equation", integrating all prior skills within a narrative climax), followed by the post-test assessment, the post-intervention engagement scale, and a final reflective journal entry.

Participants and Context

The study was conducted with 24 students (12 female, 12 male) enrolled in two sections of Grade 9 mathematics at a state Anadolu high school in Kocaeli Province, Turkey. Students ranged in age from 14 to 16 years. The school serves a socioeconomically mixed urban population and operates under the standard Turkish national curriculum framework without specialized STEM, science, or enrichment designations. Participation was entirely voluntary; following the distribution of information letters and parental consent forms, all students in the selected sections chose to participate.

In terms of prior academic achievement, the class presented a heterogeneous profile: six students had attained above-average scores on the preceding semester's mathematics examination (above 70%), eleven were at the average band (50–70%), and seven had achieved below-average scores (below 50%). This mixed-achievement composition was considered an asset for the study design, as the narrative game format was hypothesized to support differentiated engagement across ability levels by offering narrative-driven motivation that does not exclusively reward computational speed. The researcher-practitioner was also the students' regular classroom mathematics teacher, with thirty years of secondary teaching experience.

Data Collection and Analysis

A convergent mixed-methods design was employed (Creswell & Plano Clark, 2017), integrating quantitative pre-test/post-test data with qualitative observational and reflective journal data. The two data strands were collected concurrently and merged during interpretation to produce a comprehensive picture of students' experiences and outcomes.

Quantitative data were collected via two instruments. The first was a Problem-Solving Assessment (PSA) consisting of 10 open-ended, multi-step items aligned with Grade 9 curriculum objectives and scored using a 4-point analytical rubric addressing mathematical accuracy (0–2 points), quality of reasoning (0–1 point), and appropriateness of strategy selection (0–1 point), yielding a maximum score of 40 points per item, scaled to 100. Inter-rater reliability was established by having an independent mathematics teacher score 30% of the assessments blind to condition; Cohen's kappa coefficient was .84, indicating strong agreement. The second instrument was a 12-item Student Engagement Scale (SES) adapted from Skinner et al. (2009), employing a 5-point Likert format (1 = strongly disagree, 5 = strongly agree) and demonstrating satisfactory internal consistency (Cronbach's $\alpha = .87$) in the present sample.

Qualitative data were obtained through two sources: (1) structured classroom observations conducted by the researcher during each game session using a pre-determined protocol focusing on observable

indicators of participation, persistence under difficulty, and collaborative reasoning; and (2) student reflective journal entries, written at the conclusion of each weekly episode and guided by three prompts: "What was the most challenging moment for you, and how did you respond?"; "How did the story help or hinder your mathematical thinking?"; and "Describe a moment when you changed your approach to a problem."

Quantitative data were analyzed using paired samples t-tests to compare pre- and post-intervention scores on the PSA and SES. Effect sizes were calculated using Cohen's d to evaluate practical significance. Qualitative data were subjected to inductive thematic analysis (Braun & Clarke, 2006), proceeding through the phases of data familiarization, open coding, candidate theme generation, theme review and refinement, and final naming. Member checking was conducted by sharing a summary of emerging themes with six volunteer participants, all of whom confirmed the themes as broadly representative of their experiences.

FINDINGS

Quantitative Findings

Results of the paired-samples t-tests indicated statistically significant improvements in both measured outcomes following the three-week intervention. Problem-solving scores increased from a pre-test mean of 52.3 (SD = 10.4) to a post-test mean of 68.7 (SD = 9.1), $t(23) = 4.12$, $p < .001$, Cohen's $d = 0.72$, representing a large effect size by conventional benchmarks (Cohen, 1988). Engagement scale scores increased from a pre-intervention mean of 3.1 (SD = 0.61) to a post-intervention mean of 4.2 (SD = 0.54), $t(23) = 5.87$, $p < .001$, Cohen's $d = 0.68$, also constituting a large practical effect. These results are summarized in Tables 1 and 2.

Table 1.
Problem-Solving Assessment: Pre-Test and Post-Test Results (n = 24)

Measure	Mean	SD	t(23)	d
Pre-Test	52.3	10.4	4.12*	0.72
Post-Test	68.7	9.1		

* $p < .001$

Table 2.
Student Engagement Scale: Pre- and Post-Intervention Results (n = 24)

Measure	Mean	SD	t(23)	d
Pre-Intervention	3.1	0.61	5.87*	0.68
Post-Intervention	4.2	0.54		

* $p < .001$

Qualitative Findings

Thematic analysis of student journal entries and classroom observation records yielded three overarching themes: persistence under difficulty, emotional engagement with the narrative, and emergent strategic thinking. These themes are elaborated below, with supporting quotations drawn from

student reflective journals (student identifiers S1–S24 are used throughout to protect anonymity). All journal extracts were translated from Turkish by the researcher.

Theme 1: Persistence Under Difficulty. Observational records indicated that during conventional mathematics instruction in the weeks preceding the intervention, an average of 34% of students ceased working on a problem within two minutes of encountering difficulty. During narrative game sessions, this rate dropped to approximately 8%, with students frequently consulting the hint card system, attempting alternative solution approaches independently, or seeking peer input. Across the three weeks of observation, the researcher recorded a total of 47 instances of students explicitly restarting a challenge after an initial incorrect attempt — a behavior observed on only three occasions during equivalent periods of conventional instruction.

This behavioral shift was corroborated in journal entries. One student wrote: "I got stuck three times on the cipher problem, but I didn't want to stop because I needed to find the key to open the next door in the story" (S11). Another noted: "Normally when I can't do a problem I just write something random. This time I tried again because the character needed me to get it right" (S7). A third student's account was particularly revealing: "In normal maths class I give up fast because I think there is no point trying again. But here when I got the wrong answer the story punished the character, not me — and I wanted to fix it for the character" (S14). This externalization of failure appears to function as an anxiety-reducing mechanism, consistent with Lim et al.'s (2020) findings on narrative distancing in mathematics task contexts, and aligns with Hidi and Renninger's (2006) model of triggered situational interest generating maintained volitional effort.

Theme 2: Emotional Engagement with the Narrative. Students consistently described their experience using affective language that is atypical in reflections on mathematics learning. Terms such as "exciting," "like a game," "fun," and "I forgot it was maths" appeared across 19 of 24 student journals. One student articulated this shift particularly clearly: "I used to think I hate maths. Now I think I just hate how maths is usually taught. When there is a story I actually want to know what happens next, and the equation is part of the adventure" (S19). Another student, who had been among the lowest scorers on the PSA pre-test, wrote: "This week was the first time I came to maths class and felt excited. Usually I am nervous. I wanted to see what happened to the merchant" (S2). A third entry captured the functional role of narrative tension: "The story made me feel like the equation was real. Like something actually depended on getting it right" (S21).

The observation protocol recorded 38 instances of spontaneous positive affect expressions during game sessions across the three weeks, compared to two such instances during equivalent conventional lesson periods. This qualitative evidence resonates with Egan's (1986) contention that narrative creates an emotional binary — tension and resolution — that fundamentally alters the learner's relationship to content. This finding also connects to the literature on mathematics anxiety: when content is experienced as emotionally safe and engaging, the threat appraisal underlying anxiety is substantially reduced (Ashcraft & Ridley, 2005).

Theme 3: Emergent Strategic Thinking. Perhaps the most consequential qualitative finding concerns the emergence of metacognitive strategy awareness among participants. Observation notes recorded 29 distinct instances of students verbally articulating their problem-solving approach to peers ("wait, let me try substitution first"; "I think we need to set up a table before we can solve this"; "read the clue again — there is a hidden number in the story"). These verbalizations are evidence of executive functioning: students were monitoring, evaluating, and directing their own cognitive processes — precisely the metacognitive skills that predict long-term mathematical achievement (Veenman et al., 2006).

Journal entries also reflected increased strategic self-awareness across the weeks. In Week 1, most entries described what students did. By Week 3, entries described how and why students made strategic choices: "I realized halfway through that I was doing it the hard way. I stopped, re-read the clue, and started again with a simpler method" (S3); "I used trial and error on the first challenge but for the second one I wrote out all the information first and made a plan — it was faster" (S16); "I asked for a hint card but then I didn't need to use it because thinking about what kind of hint I would want helped me see the answer myself" (S22). This developmental trajectory from execution-focused to strategy-focused reflection is consistent with Polya's (1945) heuristic model and with metacognition research suggesting that explicit reflective opportunities produce measurable gains in metacognitive awareness within short intervention periods (Dignath & Büttner, 2008).

DISCUSSION

The findings of this study, taken together, suggest that the integration of narrative and game structures within a paper-based classroom format produces educationally meaningful improvements in both the affective and cognitive dimensions of secondary mathematics learning. This section situates these findings within the broader empirical and theoretical literature, addressing both convergences and divergences with prior research.

Engagement and Motivation

The large effect size observed for student engagement ($d = 0.68$) is consistent with, but somewhat larger than, effect sizes reported in previous GBL interventions in mathematics. Plass et al.'s (2015) meta-analytic review found a mean effect of $d = 0.49$ for GBL on motivational outcomes, while Lamb et al. (2018) reported $d = 0.55$ in a secondary algebra context. The somewhat larger effect observed in the present study may be attributable to the depth of narrative integration: because the story was structurally inseparable from the mathematical tasks, the motivational and cognitive elements were unified rather than merely juxtaposed. This aligns with Plass et al.'s (2015) finding that integrated GBL produces larger effects than additive gamification, and with Çakıroğlu et al.'s (2019) documentation of substantial attitude improvements following game-based mathematics instruction in the Turkish context.

The qualitative finding that 19 of 24 students spontaneously described mathematics as "fun" or "like a game" is particularly notable given the pre-intervention engagement scale average of 3.1 — a value falling in the neutral-to-slightly-agree range. Attard (2013) identified perceived relevance and emotional safety as the two most influential factors in secondary students' mathematics engagement, both of which the narrative game format appears to have provided. This shift in affective response is also consistent with Hannula's (2002) argument that attitude change in mathematics is possible when students experience the subject in a fundamentally different emotional register.

Problem-Solving Performance

The large effect size for problem-solving improvement ($d = 0.72$) warrants careful interpretation in the absence of a control group. However, several features of the data suggest a substantive intervention effect beyond maturation or practice. First, the qualitative data document specific, identifiable mechanisms — increased persistence, reduced problem abandonment, and emergent strategic planning — that are theoretically expected to produce performance gains and that were absent during pre-intervention conventional instruction. Second, the magnitude of improvement (mean gain of 16.4 points) substantially exceeds typical test-retest improvement without instruction (Wiliam, 2011).

Notably, problem-solving improvement was most pronounced among students in the below-average achievement band (mean pre-test 38.2, post-test 57.6), compared to above-average students (pre-test

71.4, post-test 82.1). This differential pattern suggests that narrative scaffolding may be particularly beneficial for students lacking established problem-solving routines, consistent with Vygotsky's (1978) Zone of Proximal Development framework: the narrative context provides an external scaffold that supports students in attempting tasks at the boundary of their current competence.

Strategic Thinking and Metacognition

The emergence of metacognitive verbalizations and strategy-focused journal entries is perhaps the most theoretically significant finding of this study, suggesting qualitative changes in students' relationship to mathematical problem-solving that may extend beyond the specific assessment context. Veenman et al. (2006) identified metacognitive skills as among the strongest predictors of long-term mathematical achievement and argued that these skills are most effectively developed through instructional approaches that make the problem-solving process visible and subject to reflection. The narrative game format's hint card system and end-of-session reflection prompts were designed precisely to create these metacognitive occasions, and the data suggest they did so.

The developmental trajectory from execution-focused to strategy-focused reflection observed across the three weeks of journalling is consistent with Dignath and Büttner's (2008) finding that explicit reflective opportunities produce measurable metacognitive gains within short intervention periods. The present study suggests that narrative game contexts may create naturally occurring occasions for this kind of engagement without the artificiality that students sometimes associate with explicit strategy instruction approaches.

CONCLUSION AND RECOMMENDATIONS

This action research study set out to examine how narrative-based notebook games affect high school students' mathematical engagement and problem-solving skills. The title phrase "from story to strategy" captures the core transformation that the intervention was designed to produce and that the findings suggest was indeed achieved: students moved from passive, compliance-driven engagement with mathematical procedures toward active, story-motivated strategic thinking about how to solve problems. This journey was not merely metaphorical — it described the concrete cognitive trajectory observed across the three weeks of the study, as students progressed from narrating what they did to analyzing why and how they chose approaches. The story was the entry point; strategy was the destination.

The combined quantitative and qualitative findings suggest that the mechanism of impact operates through three interlocking channels: the creation of a purposeful narrative context that sustains persistence under difficulty, the cultivation of genuine emotional investment in mathematical outcomes, and the scaffolding of metacognitive strategy awareness. Critically, these effects were achieved without digital technologies, demonstrating that narrative-game pedagogies are applicable in resource-constrained educational settings. This finding has relevance for the Turkish public school context, where digital infrastructure varies substantially across institutions and where the need for low-cost, high-impact instructional alternatives is acute.

Several limitations must be acknowledged. The absence of a control group precludes causal inference, and observed improvements may be partially attributable to the novelty of the instructional format (Hawthorne effect). The small sample (n = 24) limits generalizability, and the three-week intervention period does not permit conclusions about long-term retention. The researcher-practitioner dual role introduces potential observer bias, mitigated but not eliminated by the structured observation protocol. Future research should employ quasi-experimental designs with matched comparison groups, larger and

more diverse samples, and extended follow-up measurement points. It would also be valuable to examine differential effects across grade levels, curriculum domains, and student achievement profiles.

For practitioners, this study offers three concrete recommendations. First, a single well-constructed narrative scenario of 4–6 pages, aligned to a specific curricular objective, is sufficient for an initial classroom trial. Second, the quality and authenticity of the narrative is critical: students must genuinely care about the story outcome for the motivational mechanism to function. Third, a non-revealing hint card system proves effective as a metacognitive scaffold, preserving student agency while providing strategic support. The journey from story to strategy is one that mathematics teachers can facilitate with paper, pencil, and a well-crafted narrative — and the evidence suggests it is a journey worth taking.

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Appendix A. Sample Narrative Game Task — "The Time Loop" (Episode 1, Week 1)

The clock on the wall is frozen at 08:47. You have been here before — you always have. The corridors of this school shift whenever you take a wrong turn. The only way out of the loop is to prove to the mechanism that you understand the language it speaks. The mechanism speaks in equations.

Challenge 1 (Gateway Level — Linear Equations): The mechanism projects the following equation: ***2x + 5 = 17.*** The value of x is the door code. Show your full working, then select your answer.

- □ A) x = 6 → The loop resets.
- □ B) x = 5 → The door opens. [Turn to page 4 — Challenge 2.]
- □ C) x = 4 → An alarm sounds. Timeline collapses.

Reflection prompt: *Which challenge required you to change your approach? Did the story make you more or less willing to try again after getting stuck?*

Ethical Approval

This study was conducted in accordance with the ethical guidelines of the Turkish Ministry of National Education. Written informed consent was obtained from the parents or legal guardians of all student participants prior to the commencement of data collection. Student participation was entirely voluntary, and all participants were assured of the confidentiality of their individual responses and their unconditional right to withdraw at any point without academic consequence. As the study involved standard pedagogical activities implemented by the students' own classroom teacher and posed no risk of harm, formal institutional ethics board review was not required under applicable national guidelines.

Author Contributions

İsmail Kara: Conceptualized and designed the study; developed all narrative game materials; implemented the intervention; collected, analyzed, and interpreted all data; and prepared the manuscript in its entirety. The author read and approved the final version of the manuscript.

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Conflict of Interest

None declared.