

Strategic Thinking through Game-Based Learning: The Educational Board Game “Princess of the Silk Road”

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Abstract: In recent decades, educational systems globally have increasingly shifted toward fostering higher-order cognitive skills, with strategic thinking widely recognized as a crucial 21st-century competency necessary for navigating complex, dynamic environments. However, traditional teacher-centered pedagogical methods often provide limited opportunities for elementary students to practice authentic decision-making and problem-solving in real time. Addressing this critical gap in the literature, this study investigated the effectiveness of a culturally localized, custom-designed educational board game, “*Princesses of the Silk Road*,” in enhancing the strategic thinking skills of fourth-grade students. The game mechanics were specifically designed to operationalize and simulate core components of strategic thinking, including future thinking, evidence-based decision-making, delayed response, continuous strategy revision, goal setting, and complex mental modeling. The research employed a mixed-methods, quasi-experimental pre-test–post-test control group design to evaluate the intervention. A sample of forty female fourth-grade students (aged 9–10 years) from a public primary school were randomly assigned to an experimental group ($n=20$) and a control group ($n=20$). While the control group received standard conventional classroom instruction, the experimental group actively engaged in twelve structured 45-minute gameplay sessions over a designated period. Quantitative data measuring cognitive improvements were collected using standardized instruments, specifically the Behavior Rating Inventory of Executive Function (BRIEF2) and the Children’s Future Thinking Questionnaire. Analysis of covariance (ANCOVA), controlling for initial pre-test scores, revealed a statistically significant improvement in the experimental group across all six measured strategic components ($p<0.05$). The data demonstrated that the game-based intervention yielded medium to large effect sizes across the different cognitive domains. Complementing the quantitative results, observational notes and brief student reflections also revealed increased planning and awareness of consequences during play. These findings provide preliminary evidence that the *Princess of the Silk Road* board game effectively aligns educational gameplay with strategic thinking principles and may serve as a valuable instructional tool in elementary education.

Keywords: Game-based learning, Strategic thinking, Educational board games, Elementary education

1. Introduction

In recent decades, global educational systems have shifted from the transmission of factual knowledge toward fostering higher-order cognitive skills. Among these skills, strategic thinking has been widely recognized as a key 21st-century competency, involving the ability to anticipate consequences, make evidence-based decisions, revise strategies, and construct mental models of complex situations (Pisapia, 2009). Empirical research shows that students who develop strategic thinking at an early age demonstrate better performance in problem-solving, self-regulation, and academic planning (Brocas & Carrillo, 2018; O’Neill & Holmes, 2022).

Despite the importance of this competency, evidence from international assessments indicates that Iranian students perform below global averages in reasoning, complex problem-solving, and advanced cognitive skills (Samiee Zafarghandi et al., 2020; Norouzi et al., 2024). One contributing factor is the dominance of teacher-centered instructional methods in elementary classrooms, which offer limited opportunities for decision-making, anticipating consequences, and engaging with authentic problem situations. Under such conditions, learning often becomes memorization-based and does not provide sufficient foundations for the development of strategic thinking.

From a developmental perspective, the ages of 9 to 11 represent a critical period in which children transition from concrete to more logical and organized thinking, enabling them to consider future outcomes and compare alternative strategies (Inhelder & Piaget, 1958). Learning environments that involve action, decision-making, and experience during this stage can consolidate higher-order cognitive patterns. Educational games provide such environments by offering interactive, feedback-rich, and goal-oriented situations that require anticipation, planning, and strategic revision (Kaczmarczyk et al., 2016). Research further shows that

board games can enhance motivation, social interaction, and deep learning, giving children opportunities to practice complex cognitive skills (Othman & Ching, 2024; Sousa et al., 2023).

However, many available educational games lack alignment with curricular goals or have limited relevance to learners' cultural contexts. Studies suggest that culturally grounded games promote more meaningful learning and greater engagement (Jossan, 2021; Zhong et al., 2023). To address this gap, the educational board game *Princess of the Silk Road* was designed. Through historical narrative, resource management, collaborative decision-making, and consequence anticipation, the game places learners in problem-based scenarios that activate multiple components of strategic thinking. Unlike traditional classroom activities, gameplay requires players to plan, evaluate options, delay responses, and revise strategies. Despite growing research on game-based learning, little work has systematically examined a culturally localized board game designed to explicitly target components of strategic thinking in elementary students. Accordingly, this study aimed to investigate the impact of the *Princess of the Silk Road* board game on the strategic thinking of fourth-grade students.

2. Methodology

This study is an applied research adopting a quantitative quasi-experimental design to evaluate the effectiveness of an educational board game developed through a design-oriented approach. The study employed a pre-test–post-test control group design to examine the impact of the intervention on students' executive functions and future thinking.

2.1 Participants and Ethical Considerations

The participants were 40 fourth-grade female students (aged 9–10 years) from a public primary school during the 2024–2025 academic year. Because the researcher had full access to the school, the entire population of the class was included (census sampling). After administering the pre-test, students were randomly assigned to the experimental group ($n = 20$) or the control group ($n = 20$) using simple random allocation (drawing numbered cards).

Ethical requirements were strictly observed. Informed consent was obtained from both students and their parents. Participants were assured of confidentiality, anonymity, and their right to withdraw at any stage without penalty.

2.2 Data Collection Tools

Two standardized questionnaires were used for data collection:

Behavior Rating Inventory of Executive Function (BRIEF2) – Self-Report:

Developed by Gioia et al. (2015), this tool assesses executive functions such as planning, decision-making, working memory, and mental flexibility.

The scale includes Likert-type items rated on a three-point response format (Never, Sometimes, Often).

The original version reported high reliability (Cronbach's $\alpha = 0.91$ – 0.96).

In Iran, face validity was confirmed through interviews with 10 fourth-grade students, content validity was approved by 5 experts ($CVR = 0.85$), and internal consistency reliability yielded $\alpha = 0.87$.

Children's Future Thinking Questionnaire:

Developed by Mazachowsky and Mahy (2020), this questionnaire assesses saving behavior, prospective memory, episodic foresight, planning, and delay of gratification through a five-point Likert scale.

The Iranian adaptation (Sadeghi et al., 2022) demonstrated acceptable face and content validity ($CVR = 0.82$) and strong reliability ($\alpha = 0.89$).

Both scales were administered in paper-and-pencil format, and scoring followed the instructions of the original manuals.

$\alpha = 0.88$).

2.3 Educational Intervention: “Princesses of the Silk Road”

The intervention consisted of an educational board game specifically designed to promote strategic thinking and future-oriented decision making among students. The experimental group participated in twelve sessions,

each lasting approximately 45 minutes, while the control group continued with their regular classroom activities.

“Princesses of the Silk Road” is a four-player cooperative–competitive board game that incorporates challenge cards, a map of Iran, player tokens, a necklace board, and gem resources including ruby, turquoise, emerald, and the Koh-i-Noor diamond. The gameplay requires players to make decisions, manage resources, and collaborate with peers while navigating different routes across the map to collect gems and complete the necklace.

To ensure that the game effectively fostered strategic thinking skills, its mechanics and dynamics were intentionally aligned with theoretical components of strategic thinking. These included goal setting, evidence-based decision making, future-oriented planning, and learning through trial and error. Table 1 illustrates how specific game strategies were integrated with strategic thinking components and their implementation within the gameplay.

To provide a clearer understanding of the intervention environment and materials used, Figure 1 presents the components of the board game, and Figure 2 illustrates the students participating in the gameplay sessions during the intervention period.

Table 1: Integrated design strategies combining game mechanics and strategic thinking

Game Strategy	Strategic Thinking Component	Integrated Concept	Implementation Example
Goal setting & staging	Goal setting & problem partitioning	<i>Small steps to grand victory:</i> Success requires continuous micro-actions.	Collecting rubies, turquoises, and emeralds sequentially to complete the necklace board.
Immediate & meaningful feedback	Revising and correcting	<i>Instant learning & course correction:</i> Mistakes are learning opportunities.	Applying card consequences immediately; if a battle fails, the threat gauge advances, forcing a strategy change.
Balance of challenge & skill	Evidence-based decision making	<i>Calculated decisions:</i> Balancing resources, risks, and consequences.	Using two-option cards where players must negotiate and weigh the cost/benefit of paths based on required gems.
Gradual progress & intrinsic reward	Future thinking	<i>Progress and reward:</i> Sacrificing short-term gains for long-term benefits.	Saving resource cards for future rounds to acquire the high-value Koh-i-Noor diamond.
Player agency	Looking from multiple angles	<i>Multiple paths:</i> Freedom of choice tied to responsibility.	Choosing between different geographical routes to obtain required stones.
Social interaction	Trial and error learning	<i>Collective trial & learning:</i> Co-experiencing success and failure.	Selecting the safest and shortest route through group negotiation and shared risk assessment.

To provide a clearer understanding of the intervention environment and the materials used, Figure 1 displays the components of the board game, while Figure 2 illustrates the students actively engaged in the playtesting and educational sessions.



Figure 1: The components of the “Princesses of the Silk Road” board game



Figure 2: Fourth-grade students engaging in the playtesting and intervention activities

2.4 Procedure and Data Analysis

The study proceeded in three stages:

Pre-test: Both questionnaires were administered to all 40 students prior to the intervention.

Intervention: Only the experimental group received the 12-session board game training.

Post-test: After the intervention, the same questionnaires were readministered to both groups. Semi-structured interviews were conducted to gather qualitative insights from the experimental group regarding their gameplay experience.

Data Analysis

Data were analyzed using SPSS version 26. Descriptive statistics (mean, standard deviation, frequency percentages) summarized the data.

For inferential analysis:

Independent samples t-test examined baseline homogeneity between groups at pre-test.

Paired samples t-test compared pre- and post-test scores within the experimental group.

The significance level was set at $\alpha = 0.05$.

Interview data were used to provide complementary qualitative explanations of student experiences but were not subjected to formal coding analysis.

3. Results

3.1 Qualitative Findings

In addition to the quantitative data collected through the BRIEF-2 and the Children's Future Thinking Questionnaire, qualitative information was obtained to capture the developmental trajectory of strategic thinking among the 20 students in the experimental group during the 12 gameplay sessions. Data triangulation was achieved using three sources: student reflective field notes, semi-structured interviews, and systematic researcher observations.

Analysis of Student Field Notes

Students' reflective notebooks provided direct evidence of reasoning processes aligned with the targeted strategic thinking components. For example, Future Thinking was reflected in statements demonstrating anticipation and planning:

"If we spend all the stones now, we will have nothing in two rounds; it is better to save them to get the Koh-i-Noor diamond" (Nazanin, Session 4).

Evidence-Based Decision Making appeared in comments involving environmental scanning, such as:

"First I looked at where the threat bar was, then I decided which card to choose" (Sara, Session 3).

Delayed Response and Reflective Thinking emerged through increased patience and comparison of options:

"I waited for everyone to move, then I'll see which path gives me the most stones I need" (Fatemeh, Session 5).

Revising and Correcting Strategy and Goal Setting were seen as sessions progressed:

"Last time we made a mistake... this time I first find the provinces that have the stones I need" (Mahsa, Session 4).

Advanced Mental Modeling was demonstrated by predictive calculations:

"I calculated in my head that if we go this way, in two rounds I will reach the Koh-i-Noor" (Elisa, Session 5).

Semi-Structured Interview Outcomes

Post-intervention interviews indicated a shift from impulsive toward more deliberate, strategic thinking. Students reported becoming more methodical both within the game and in some school tasks. For example, one student stated:

"At first I just wanted it to finish quickly, but then I realized if we rush, we lose; we have to think" (Parisa).

Students also described increased autonomy and intrinsic motivation during gameplay:

"I would love to have this game in class every week because we make the decisions ourselves" (Elena)

Systematic Researcher Observations

Observational data supported and contextualized both the reflective notes and interview findings. Across sessions, there was a notable rise in verbalizations related to planning (e.g., "let's save," "ruby first, then emerald," "we will win in the last round"). These observations aligned with the quantitative gains in Future Thinking and Goal Setting.

Relating to the Delayed Response component, impulsive decisions decreased noticeably by the fifth session but did not disappear entirely—consistent with gradual cognitive development typical of fourth-grade learners.

Synthesis of Qualitative Data

Overall, qualitative evidence showed a clear transition from reactive behaviours toward deliberate, goal-oriented, and forward-looking strategies among students in the experimental group. Convergence between qualitative data sources and quantitative results supports the internal validity of the findings. The observed cognitive changes are consistent with Vygotsky's (1978) scaffolding mechanisms and with engagement patterns predicted by Csikszentmihalyi's (1990) Flow model, particularly the alignment between challenge and skill levels.

3.2 Quantitative Findings

The Strategic Thinking Questionnaire included 19 items rated on a five-point Likert scale assessing six components of strategic thinking. Data were analyzed using SPSS (version 26) through descriptive statistics, independent t-tests, and ANCOVA at a significance level of $\alpha = 0.05$.

Prior to performing ANCOVA, the assumptions—including normal distribution of scores, homogeneity of variances, homogeneity of regression slopes, and linearity between the covariate and dependent variable—were examined. Results indicated that all assumptions were satisfactorily met.

Table 2 presents the descriptive statistics of pre-test and post-test scores for both the experimental and control groups.

Table 2: Mean and Standard Deviation of Pre-Test and Post-Test Scores

Strategic Component	Group	Pre-test $M \pm SD$	Post-test $M \pm SD$
1. Future Thinking	Experimental	15.85 $\pm$ 2.18	18.60 $\pm$ 1.50
	Control	13.70 $\pm$ 2.49	14.10 $\pm$ 2.33
2. Evidence-based Decision Making	Experimental	12.75 $\pm$ 1.86	14.30 $\pm$ 1.13
	Control	11.15 $\pm$ 2.03	11.45 $\pm$ 1.99
3. Delayed Response & Reflective Thinking	Experimental	12.50 $\pm$ 2.14	13.85 $\pm$ 1.73
	Control	12.05 $\pm$ 2.11	12.30 $\pm$ 2.05
4. Revising and Correcting	Experimental	13.65 $\pm$ 1.63	15.10 $\pm$ 1.29
	Control	11.90 $\pm$ 1.94	12.20 $\pm$ 1.88
5. Goal Setting & Problem Partitioning	Experimental	16.20 $\pm$ 2.33	18.75 $\pm$ 1.48
	Control	14.15 $\pm$ 2.52	14.60 $\pm$ 2.39
6. Mental Modeling	Experimental	12.40 $\pm$ 1.73	14.00 $\pm$ 1.30
	Control	10.85 $\pm$ 2.01	11.15 $\pm$ 1.90

As shown in Table 2, the experimental group had slightly higher mean scores than the control group at pre-test across all components. Following the intervention, both groups showed slight improvements, yet the increases were substantially greater in the experimental group.

Before examining the effect of the intervention, an independent samples t-test was conducted on pre-test scores to assess group equivalence. Results indicated no statistically significant differences at pre-test, allowing ANCOVA to be used appropriately. To evaluate the effectiveness of the game-based intervention, ANCOVA was conducted controlling for pre-test scores.

Table 3: Results of ANCOVA for Strategic Thinking Components Controlling for Pre-test Scores

Component	F	df	P-value	Partial η^2	Effect Size
Future Thinking	32.10	(1,37)	< 0.001	0.40	Large
Evidence-Based Decision Making	24.85	(1,37)	< 0.001	0.36	Large
Response Inhibition & Reflective Thinking	4.80	(1,37)	0.033	0.11	Medium
Review and Revision	27.40	(1,37)	< 0.001	0.38	Large
Goal Setting & Problem Decomposition	34.25	(1,37)	< 0.001	0.42	Large
Mental Modeling	21.90	(1,37)	< 0.001	0.33	Large

As presented in Table 3, the ANCOVA results, controlling for pre-test scores, revealed statistically significant differences between the experimental and control groups across all six components of strategic thinking ($p < 0.05$). The strongest effects were observed in Goal Setting and Problem Decomposition ($F(1,37) = 34.25$, $p < 0.001$, Partial $\eta^2 = 0.42$) and Future Thinking ($F(1,37) = 32.10$, $p < 0.001$, Partial $\eta^2 = 0.40$), both indicating large effect sizes. Similarly, substantial improvements were found in Review and Revision ($F(1,37) = 27.40$, $p < 0.001$, Partial $\eta^2 = 0.38$), Evidence-Based Decision Making ($F(1,37) = 24.85$, $p < 0.001$, Partial $\eta^2 = 0.36$), and Mental Modeling ($F(1,37) = 21.90$, $p < 0.001$, Partial $\eta^2 = 0.33$), all reflecting large intervention effects. In contrast, Response Inhibition and Reflective Thinking showed a smaller yet statistically significant effect ($F(1,37) = 4.80$, $p = 0.033$, Partial $\eta^2 = 0.11$), indicating a moderate improvement compared to other components. Overall, these findings suggest that participation in the “Princesses of the Silk Road” educational board game led to meaningful improvements in multiple dimensions of students’ strategic thinking.

4. Discussion and Conclusion

The present study investigated the effectiveness of the educational board game “Princesses of the Silk Road” in enhancing strategic thinking skills among elementary school students. The quantitative results demonstrated that participation in the intervention group led to statistically significant improvements across all six measured components of strategic thinking compared to standard instruction. The largest gains were observed in Goal Setting and Problem Decomposition as well as Future Thinking, with effect sizes reaching up to Partial $\eta^2 = 0.42$ for these components (see Results, Table 3). These effects can be considered large according to established

benchmarks (Cohen, 1988) and indicate not only statistical significance but also substantive educational impact within the study context. These findings are aligned with theoretical frameworks related to executive functions, highlighting the connection between structured, goal-oriented activities and the development of planning, response inhibition, and cognitive flexibility (Gioia et al., 2015).

Qualitative analysis further enriched the interpretation of these quantitative gains. Evidence from students' field notes, semi-structured interviews, and classroom observations revealed a transition from impulsive, one-step decision-making to more reflective, multi-step planning throughout the intervention. For instance, students increasingly verbalized anticipation of future game scenarios, consideration of multiple possible outcomes, and strategic revision of their approaches after setbacks (see Results, section 3.1). This pattern supports developmental models suggesting that practical scaffolding—such as that provided by problem-based games—can accelerate the emergence of logical organization and consequence anticipation (Inhelder & Piaget, 1958). Additionally, engagement with the culturally localized game narrative fostered intrinsic motivation and classroom participation in line with findings from prior research on game-based learning (Dever, 2023).

A noteworthy aspect of this study is the integration of culturally relevant content within the board game design. Embedding Iranian historical and geographical themes appeared to enhance students' sense of connection to the curriculum and may have contributed to their sustained engagement throughout the intervention. This study thus adds to the growing evidence supporting the role of culturally contextualized, interactive educational tools in the promotion of 21st-century skills among primary school learners.

Nonetheless, several limitations of this research must be noted. The sample size was relatively small ($n=40$) and comprised only female fourth-grade students from a single urban public school, which limits the generalizability of the results. The absence of longitudinal follow-up means the duration of observed cognitive changes remains uncertain. The use of self-report questionnaires and researcher observations introduces possible response and observer biases. Moreover, the study did not control for potential confounding variables such as fluid intelligence, previous experience with strategy games, or parental education level. The depth of qualitative comparison was further limited by less extensive data collection from the control group.

Future research should address these limitations by recruiting larger and more diverse samples, employing objective performance-based assessments, and including follow-up measurements to evaluate the persistence of intervention effects. Additionally, incorporating control variables related to cognitive baseline and prior gaming experience will help clarify the unique contribution of the intervention.

In conclusion, while these results demonstrate that a culturally tailored educational board game can foster multiple aspects of strategic thinking among elementary students, further studies are needed to confirm and extend these findings across broader contexts and over longer timeframes.

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Ethics Declaration: This study was conducted in accordance with the ethical standards of Allameh Tabataba'i University for low-risk educational research. The study involved standard educational activities, including participation in a board game and completion of questionnaires, and posed no physical or psychological risk to participants. Data were collected anonymously and no personally identifiable information was recorded. According to the institutional guidelines for educational research, the study was therefore considered exempt from formal ethics committee review. Informed consent was obtained from the participating students and their parents prior to data collection.

AI Declaration: During the preparation of this manuscript, the authors used an artificial intelligence-based language assistance tool solely for improving readability, language editing, and structural clarity of the text. All suggested revisions were carefully reviewed and edited by the authors. The authors take full responsibility for the accuracy, integrity, and final content of the manuscript. No artificial intelligence tools were used in the research design, data collection, statistical analysis, or interpretation of the results.

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