# POST-GAME PROJECT REPORT TEMPLATE FOR GAMIFIED ACADEMIC COURSES

## Project Information

**Team Information** 1

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School: Istanbul Kultur University

Semester:Spring

Course Code: SEN4012

Course Name: Analysis of Algorithms

Team Name:Binary Blossoms

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Project Overview

Project Name: Learning Algorithms With Games

Type: (**Digital** / Physical / Hybrid)

Description: This project presented three algorithmic mini-games to teach and reinforce concepts of algorithmic thinking and time complexity: Selection Sort, Binary Search, and Greedy Algorithm. Each game provided hands-on, competitive simulation of the logic behind each algorithm, reinforcing comprehension through active participation and performance-based scoring.

**1. Introduction**

This post-game project report serves as a comprehensive documentation of the *Learning Algorithms With Games* simulation developed by the Binary Blossoms team. Designed within the scope of the SEN4012 – Analysis of Algorithms course at İstanbul Kültür University, the project aimed to teach algorithmic thinking through interactive, gamified experiences.

The report traces the journey of the project from its proposal phase—where algorithm education was reimagined as an engaging game-based activity—through to its real-world classroom implementation. By comparing planned objectives, game mechanics, and expected learning outcomes with the actual execution data collected (e.g., scores, player logs, and surveys), this report presents a transparent and evidence-based evaluation of the project.

It also outlines key variances between theoretical planning and practical application, offering critical insights for improving future implementations. Through this reflection process, the report not only validates the pedagogical value of gamification but also proposes enhancements to expand the reach and impact of similar educational games. The document concludes with stakeholder evaluations and strategic recommendations based on performance indicators and direct feedback from participants.

## 2. Project Proposal vs. Actual Outcome

### 2.1. Educational Objectives & Learning Outcomes

Planned:

* Teach algorithmic thinking (sorting, searching, and greedy selection)
* Reinforce time complexity understanding with active examples
* Promote fun and collaborative learning

**Actual Outcome:**

* **[Primary Objective 1]:** Students demonstrated a clear understanding of algorithmic thinking by actively engaging with physical simulations of Selection Sort, Greedy Algorithm, and Binary Search. The structure of each game effectively mirrored the logical steps of the respective algorithm.
* **[Primary Objective 2]:** Participants successfully internalized time complexity concepts by associating each algorithm with a hands-on task. The swap count in Selection Sort, step count in Binary Search, and weight-value tradeoff in the Greedy algorithm reinforced Big-O logic.
* **[Primary Objective 3]:** Students showed improvement in problem-solving skills and decision-making under time pressure, reflecting growth in analytical thinking and strategy development.
* **Secondary Benefits:** The game format increased motivation and engagement, especially among visual and active learners. The physical and competitive nature of the games fostered collaboration, peer learning, and self-reflection. The leaderboard and scoring system created a sense of mastery and encouraged repeated participation for improvement.

**Variance/Lessons Learned:** Students responded positively to physical simulations. Slight variations in ideal steps vs. performed steps revealed areas of misunderstanding, especially in Binary Search.

### 2.2. Game Flow & Scenario Execution

Planned:

The game was designed with distinct phases:

* **Introduction & Role Assignment (30 seconds):** Players were introduced to the game and assigned to one of the three algorithm games (Selection Sort, Greedy Algorithm, Binary Search).
* **Phase 2 – Algorithm Challenge (1–5 minutes depending on the game):** Players actively played the game designed for their group, solving algorithmic tasks within a timed session.
* **Phase 3 – Scoring & Review (30 seconds):** Scores were calculated based on performance metrics such as swap count, steps taken, and collected value.
* **Review & Reflection (30 seconds):** Players received immediate feedback on their performance, including ideal outcomes and areas for improvement.

Total gameplay duration was strictly limited to **under 5 minutes** per session.  
Scenarios included:

* Unsorted input for sorting algorithms,
* Search within range,
* Greedy item selection under weight constraints.  
  Randomness was introduced through **shuffling, random target placement, and dynamic weights**.

**Actual Outcome:**

* **Game Duration Adherence:** Planned time limits were consistently met. Each algorithm game was designed to auto-terminate or trigger a “Time’s Up!” screen. No major challenges were encountered in enforcing duration.
* **Phase Transitions:** Phase transitions occurred smoothly. Players moved from introduction to gameplay without confusion, and post-game scoring screens provided clear closure before feedback.
* **Scenario Play-out:** All intended scenarios were executed as planned. For example, Binary Search began with a randomly selected target, and Greedy Algorithm games offered dynamic item values and constraints. Players responded effectively to scenario conditions.
* **Algorithm Execution:** All algorithmic implementations, such as step counting in Binary Search, swap tracking in Selection Sort, and greedy decision logging executed correctly without technical issues. Scoring algorithms were consistent and accurate across player groups.

**Variance/Lessons Learned:** Although the overall game flow followed the planned structure, a few valuable insights emerged:

Binary Search Algorithm players occasionally misunderstood the game and randomly select values, requiring more explaning about the game in the page. Information can be provided on the screen instead of the information button.

Some players finished early. Including optional challenge rounds or bonus stages could keep engagement high post-completion.

Player feedback suggested that the review/reflection phase could be more interactive, e.g., with animations or comparative visualizations.

### 2.3. Scoring System & Rewards

Planned:

A comprehensive scoring system was defined, including:

* **Standard task completion points**, such as:
  + 100 points for reaching the ideal number of swaps (Selection Sort),
  + 100 points for finding the target in the minimum steps (Binary Search),
  + 100 points for achieving or getting close to the ideal weight-value ratio (Greedy Algorithm).
* **Penalties** included reduced points for inefficient paths (e.g., extra swaps or excessive search steps).
* Each player operated within a 3-member group, where every individual contributed by playing and completing one of the algorithm-based mini games (Selection Sort, Binary Search, or Greedy Algorithm).

**Actual Outcome:**

* **Point Calculation Accuracy:** The scoring system functioned correctly in real time. Each game dynamically calculated the score based on objective metrics (swaps, steps, values). No major discrepancies were reported during score verification.
* **Group Contribution**: Each player operated within a 3-member group, where every individual contributed by playing and completing one of the algorithm-based mini games (Selection Sort, Binary Search, or Greedy Algorithm). Their individual performances not only reflected personal understanding but also collectively determined the group’s total achievement and position, reinforcing collaborative learning through distributed responsibility.
* **Leaderboard Publication:** A leaderboard was published at the end of each session. It displayed all participant names with their respective scores. Players could immediately compare performance.
* **Personal Point Calculation:** Players received clearly calculated personal scores based on how closely they matched the ideal outcome. This was communicated via the end screen and reinforced in debrief sessions. All participants understood the system.
* **Game Leaders Recognition:** Top scorers in each group were recognized. For example, students who scored 100 points (e.g., Ozan Yazıcı, İpek Tünay) were highlighted as round winners.

**Variance/Lessons Learned:**

The leaderboard feature successfully triggered competitive and collaborative engagement.

Future versions could benefit from dynamic difficulty-based scoring multipliers or time bonuses to enhance strategy depth.

### 2.4. Game Management and Support

Planned:

A Gamification Team (Binary Blossoms) was responsible for:

* Executing the gameplay sessions,
* Providing real-time technical support,
* Managing player flow and in-game logistics,
* Collecting logs (e.g., scores, time taken, action paths),
* Tracking and calculating player points,
* Publishing a session-end leaderboard.

A **digital web-based app** (developed with **Flask for backend and JavaScript for frontend**) was used for:

* Tracking game progress,
* Recording gameplay events,
* Assigning scores based on algorithm performance,
* Displaying final scores

**Actual Outcome:**

* **Gamification Team Effectiveness:**

The Binary Blossoms team successfully executed all sessions with minimal disruption. Each team member was assigned a specific task (timer control, score tracking), ensuring smooth flow. Coordination among members was strong, especially during transitions and support moments.

* **Digital Tool Functionality:** The web application functioned reliably across all sessions. It allowed for:

Real-time point tracking based on input (e.g., number of swaps, steps, values),

Immediate result calculation and display,

Quick leaderboard updates.  
No technical crashes or delays occurred. The UI was clear and user-friendly for both players and facilitators.

* **Log Collection Process:** All game data (including timing, steps, scores, and player names) were automatically logged in a structured JSON file. This allowed seamless documentation and post-game analysis. Manual backup was also maintained.
* **Leaderboard Management:** Leaderboards were generated in real time and shown at the end of each session. Players could clearly see their ranking and performance metrics compared to peers. This fostered motivation and engagement.
* **Support to Game Designers:** The team provided active support to both players and peer designers by explaining game rules, resolving interface questions, and adapting quickly to feedback. This helped maintain flow and avoid confusion during gameplay.

**Variance/Lessons Learned:** A lesson learned was that **clear role division within the gamification team** is crucial for managing both digital and physical logistics, especially in time-constrained environments.

### 2.5. Risks & Mitigation Strategies

Planned: 1

Key risks were identified and categorized using Tusler's Classification (Kitten, Puppy, Alligator, Tiger), including:. Mitigation strategies were proposed for each.

**Actual Outcome:**

* **Risk Occurrence:**
* Minor confusion among a few players about the Greedy Algorithm logic occurred.
* No technical crashes or time overruns happened.
* **Impact of Risks:**
* Confusion slightly delayed player progress in one session but was resolved with verbal clarification.
* All other planned risks did not materialize thanks to pre-testing and clear roles.
* **Mitigation Effectiveness:**
* The timer-based auto-end system worked perfectly and **fully mitigated** time management risks.
* Real-time verbal support by team members minimized the impact of confusion.
* **New Risks Identified:**
* **Superficial Application of Binary Search Logic**
  + **Description:** In the Binary Search game, some players reached the correct result through guessing, without fully grasping the algorithm’s core principle of systematically narrowing the search range.
  + **Tusler Classification:** Puppy (High Probability with Low Impact)
  + **Impact:** While players completed the game successfully, the lack of deeper understanding limited the educational value, as they did not internalize the divide-and-conquer concept.
  + **Preventive:** Visually highlight the active search range at each step using shaded areas or color-coded indicators.
  + **Responsive:** At the end of the game, provide a breakdown showing which parts of the list were eliminated and why, to reinforce the logic of binary search.

**Variance/Lessons Learned:**

The initial risk assessment was largely accurate. Most anticipated risks were either prevented or smoothly handled.

One insight was the importance of live human guidance even in tech-supported games no matter how intuitive the interface, in-person clarification ensures flow.

Future versions should **reinforce intended logic paths**, especially for algorithms that allow multiple solution strategies (e.g., Greedy).

## 3. Game Participants and Roles

**Total Players:**

**Assigned Roles:**

Each 3-person group played all 3 games, 1 per person.

**Group 1**

* P1: Elif Yavuz – Selection Sort
* P2: Duygu Demirci – Binary Search
* P3: Viyan Nafi – Greedy Treasure Hunt

**Group 2**

* P4: Mehmet Baran Dedeoğlu – Selection Sort
* P5: İpek Tünay – Binary Search
* P6: Yasin Alboru – Greedy Treasure Hunt

**Group 3**

* P7: Ahmet Faruk Bilen – Selection Sort
* P8: Kaan Yegül – Binary Search
* P9: Gülbahar Elmas – Greedy Treasure Hunt

**Group 4**

* P10: Ayça Kayacalı – Selection Sort
* P11: Erhan Arslan – Binary Search
* P12: melih sarp – Greedy Treasure Hunt

**Group 5**

* P13: Ozan Yazıcı – Selection Sort
* P14: Timur Demir – Binary Search
* P15: Özgür Deniz Hınçal – Greedy Treasure Hunt

**Group 6**

* P16: Ahmet Boray İncesoy – Selection Sort
* P17: Fatih Coşar – Binary Search
* P18: Hasan Taha Özlü – Greedy Treasure Hunt

**Group 7**

* P19: Mustafa Kuyumcu – Selection Sort
* P20: Enes İsaoglu – Binary Search
* P21: Asma Mohamed Hassan – Greedy Treasure Hunt

**Group 8**

* P22: Ayşenur Sarıca – Selection Sort
* P23: Saadet Babal – Binary Search
* P24: Ece Özcan – Greedy Treasure Hunt

**Group 9**

* P25: Busenaz Elik – Greedy Treasure Hunt

## 4. Game Log: Scenes, Scenarios, Discussions, Decisions, and Points

This section provides a detailed, chronological log of the simulated game session, including discussions, decisions, and the points earned or penalties incurred by each player at every event.

**Initial State:**

* **Players Active: 25 (9 groups; 8 groups of 3, 1 group of 1)**
* **Roles:**

Each group member played one of the following:  
 ○ Selection Sort Player (Sorter)  
 ○ Binary Search Player (Searcher)  
 ○ Greedy Algorithm Player (Hunter)

**Sort Game Players:** 8  
**Search Game Players:** 8  
**Greedy Game Players:** 9

* **Game Objective:** Maximize individual and group performance by accurately and efficiently executing algorithm-based tasks. Each player's performance contributes to the group's total score.

### Round 1: Game Execution Phase

**Scenario:** Players are assigned to algorithm-based games and perform their tasks within the given time.

* **AI/Game Master Action:** " Each participant, please proceed to your assigned game module. Your task is to complete the given objective within the time limit. Scores will be calculated based on accuracy and efficiency."
* **Player Discussions & Decisions:**

Although games were played individually, students quickly exchanged tips and strategies before starting:

* In Group 1, Elif (Sorter) said, “I’ll try not to waste any swaps.”
* In Group 5, Yasin (Hunter, “Let’s see which items give the most value for the least weight, I’ll work my way from the most valuable item.”
* In Group 3, Kaan (Searcher), “I’ll cut the list in half every time. Just like we learned.”
* **Team Decision:** Each group agreed to individually focus on accuracy but reconvene after the session to discuss what they learned about each algorithm.
* **AI/Game Master Result:** "All game modules functioned as expected.

No technical errors occurred.

Logs were successfully recorded via the digital system.

Leaderboards were generated automatically.

All students completed their games within the given time limits (ranging from 15–60 seconds depending on the algorithm complexity)."

* **Points Awarded/Penalized:**

Based on real-time collected data from scores.json, scores ranged from 40 to 100.

**Top Performers:**

* + *Sort:* Ozan Yazıcı, Ahmet Faruk Bilen (100 points, ideal swaps)
  + *Search:* Timur Demir, Fatih Coşar (100 points, < ideal steps)
  + *Greedy:* Hasan Taha Özlü, Gülbahar Elmas (100 points, ideal capacity)
* **Player Status Update :** All players completed the tasks successfully. Minor deviations occurred in the greedy algorithm game.

### Round 2: Cross-Group Performance Comparison

**Scenario:** Group totals are evaluated to determine collaborative success.

* **AI/Game Master Action:** "Group scores are calculated by averaging the individual scores of the three group members to ensure fairness across different performance types."
* **Current State:**
  + **Players Active: 25 (9 groups; 8 groups of 3, 1 group of 1)**
  + **Roles:** Group 1-9
  + **Discussion & Decisions:**
  + **(P6 – Yasin Alboru):** “We focused on accuracy over speed. Taking a few extra seconds helped us make optimal decisions.”  
     **(P7 – Gülbahar Elmas):** “We communicated before the round and agreed to follow the exact logic steps we learned in class.”
* **Team Decision:**  
   "Groups discuss strategies used and share lessons during reflection. Most noted that planning beforehand and staying calm under time pressure contributed to higher scores."
* **AI/Game Master Decision/Result:** "Points are confirmed, leaderboard finalized. Groups with balanced performance across all three roles ranked highest."
  + **Points Awarded/Penalized:**  
     Group 3: 300 points (100 average) – No penalty  
     Group 5: 289 points (96.33 average) – No penalty  
     Group 8: 230 points (76 average) – Minor penalties due to early termination and missed steps
* **Player Status Update (if applicable):** All players completed their tasks. No disqualifications or rule breaches occurred. Group 9 played with a single participant due to absence and was evaluated separately.

### Game End Condition Check

* **Current State:**
  + **Players Active: 25 (9 groups; 8 groups of 3, 1 group of 1)**
  + **Roles:**

**Sort Game Players:** 8  
**Search Game Players:** 8  
**Greedy Game Players:** 9

* + **AI/Game Master Result:** "All game sessions have concluded. The system has successfully recorded each player’s performance. Individual scores have been compiled and group averages calculated. Leaderboard finalized. Thank you for participating — review your results to reflect on how your algorithmic thinking impacted your outcome!"
* **Game Outcome:** All players fulfilled their roles. Scores varied based on algorithmic accuracy and strategy. The game successfully facilitated learning through simulation and collaborative performance.

## 5. Final Player Scores and Leaderboard

**Total Positive Points Collected in Game:**

**Individual Player Scores and Percentage of Total Points:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Player ID** | **Role (Final)** | **Raw Score** | **Percentage of Total Points Collected** | **Group Averages Scores** |
| **P1** | **Elif Yavuz** | **100 points** | [4.382]% | 95 |
| P2 | Duygu Demirci | 100 points | [4.382]% |
| P3 | Viyan Nafi | 85 points | [3.724]% |
| P4 | Mehmet Baran Dedeoğlu | 80 points | [3.505]% | 93.33 |
| P5 | İpek Tünay | 100 points | [4.382]% |
| P6 | Yasin Alboru | 100 points | [4.382]% |
| P7 | Gülbahar Elmas | 100 points | [4.382]% | 100 |
| P8 | Kaan Yegül | 100 points | [4.382]% |
| P9 | Ahmet Faruk Bilen | 100 points | [4.382]% |
| P10 | Erhan Arslan | 100 points | [4.382]% | 90 |
| P11 | Ayça Kayacalı | 80 points | [3.505]% |
| P12 | Melih Sarp | 90 points | [3.943]% |
| P13 | Ozan Yazıcı | 100 points | [4.382]% | 96.33 |
| P14 | Timur Demir | 100 points | [4.382]% |
| P15 | Özgür Deniz Hınçal | 89 points | [3.900]% |
| P16 | Ahmet Boray İncesoy | 80 points | [3.505]% | 93.33 |
| P17 | Fatih Coşar | 100 points | [4.382]% |
| P18 | Hasan Taha Özlü | 100 points | [4.382]% |
| P19 | Enes İsaoğlu | 60 points | [2.629]% | 83.33 |
| P20 | Asma Mohammed Hassan | 100 points | [4.382]% |
| P21 | Mustafa Kuyumcu | 90 points | [3.943]% |
| P22 | Ayşenur Sarıca | 40 points | [1.752]% | 76 |
| P23 | Ece Özcan | 100 points | [4.382]% |
| P24 | Saadet Babal | 90 points | [3.943]% |
| P25 | Busenaz Elik | 98 points | [4.294]% | 98 |

**Final Group Leaderboard (Ranked by Raw Score):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rank** | **Group ID** | **Role** | **Total Points** | **Average Points Earned** |
| 1 | **G1** | Sorter, Searcher, Hunter | 285 | 95/100 |
| 2 | G2 | Sorter, Searcher, Hunter | 280 | 93.33/100 |
| 3 | G3 | Sorter, Searcher, Hunter | 300 | 100/100 |
| 4 | G4 | Sorter, Searcher, Hunter | 270 | 90/100 |
| 5 | G5 | Sorter, Searcher, Hunter | 289 | 96.33/100 |
| 6 | G6 | Sorter, Searcher, Hunter | 280 | 93.33/100 |
| 7 | G7 | Sorter, Searcher, Hunter | 250 | 83.33/100 |
| 8 | G8 | Sorter, Searcher, Hunter | 230 | 76/100 |
| 9 | G9 | Hunter | 98 | 98/100 |

**Game Leaders Recognition:** was recognized as the 'Game Master'."]

## 6. Game Evaluation Report

The development and implementation of *Learning Algorithms With Games* met and exceeded our initial expectations. The primary goal was to create an engaging, educational experience that translated complex algorithmic processes into interactive gameplay—and this was successfully achieved.

Each game was designed to reflect a specific algorithm (Selection Sort, Binary Search, Greedy) and allowed students to internalize logic through timed challenges, visual movement, and competitive motivation. As the game creators, we observed not only increased student participation but also stronger retention of concepts compared to traditional lecture methods.

We are especially proud of the adaptive scoring system, which gave accurate feedback based on optimal vs. actual performance. The structure supported individual assessment while encouraging fair competition among students.

From a development standpoint, our biggest success was aligning technical implementation with pedagogical goals. Designing UI constraints that enforced algorithm rules (e.g., only adjacent swaps, binary midpoint ranges) without confusing the player required thoughtful planning and iteration.

This experience confirmed the value of gamified education. It revealed that with well-defined mechanics and learning objectives, games can effectively reinforce abstract computer science topics in a memorable and scalable way.

### 6.1. Game Owners' Evaluation (Team Proposing the Game)

**Checklist: Adherence to Project Proposal**

|  |  |  |
| --- | --- | --- |
| **Aspect** | **Adhered (Yes/No/Partial)** | **Comments/Variance** |
| Educational Objectives Met | [Yes] | All three algorithm concepts (Selection Sort, Binary Search, Greedy) were taught through interactive play and measured effectively. Students showed improved understanding. |
| Game Flow Executed as Planned | [Yes] | Game flow followed the planned sequence: introduction - execution - debrief, without deviation. All players finished within time. |
| Scoring System Accuracy | [Yes] | The scoring formulas were applied correctly. No issues reported in fairness or real-time feedback. |
| Risk Mitigation Effectiveness | [Yes] | Tutorial panels and timers prevented confusion. No rule misunderstandings occurred. |
| Overall Project Vision Achieved | [Yes] | The project succeeded in making algorithm learning fun and interactive while preserving academic integrity. |

**Table: Key Performance Indicators (KPIs) - Planned vs. Actual**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **KPI** | **Planned Target** | **Actual Result** | **Variance** | **Comments** |
| **Completion Rate** | 80% | 100 % | +20% | All players completed their assigned games successfully within time |
| **Accuracy Rate** | 75% | 88% | +13% | Many players matched or nearly matched ideal steps/values. |
| **Game Duration** | within 30 min | within 30 min | 0 | Each game was capped at 5 min per player; total session managed efficiently. |
| **Player Engagement Score** | 4.0/5.0 | 4.0/5.0 | 0 | Players reported high satisfaction and understanding of algorithm logic. |

**Overall Feedback:**

* **Overall Success:** The project was a strong success. Students fully engaged with each game, and their performance data reflected real understanding of algorithmic strategies. The most successful aspect was how quickly players adapted complex algorithm logic into action-based gameplay. The games transformed abstract sorting, searching, and greedy decision-making principles into visual, time-pressured tasks that students found enjoyable and memorable.
* **Major Challenges Encountered:** Balancing scoring formulas across different games posed a challenge. Each algorithm had unique characteristics (e.g., Binary Search being step-limited vs. Greedy having weight-based scoring), which required thoughtful normalization. Designing interfaces that enforced algorithmic logic (like limited swaps or binary range constraints) without breaking flow was also technically demanding.
* **Unexpected Findings/Outcomes:**

Students performed better under time constraints than anticipated.

Binary Search game results showed most players exceeded the “ideal step count,” yet still understood the algorithm logic.

Some students used teamwork or observation strategies despite the individual nature of the game.

* **Recommendations for Future Iterations:**

Expand game pool to include algorithms like Quick Sort, Merge Sort, or Graph-based algorithms.

Integrate adaptive difficulty scaling based on previous round performance.

Add instant feedback per action to reinforce learning moment-to-moment.

Include analytics dashboards for live tracking of learning outcomes.

### 6.2. Gamification Team's Evaluation

**Checklist: Operational Efficiency and Support**

|  |  |  |
| --- | --- | --- |
| **Aspect** | **Rating (Excellent/Good/Fair/Poor)** | **Comments/Challenges** |
| Game Setup & Logistics | |  | | --- | |  | | Excellent | | Materials were distributed efficiently; setup was intuitive and zones were clearly defined. |
| Technical Support Responsiveness | |  | | --- | |  | | Excellent | | No significant technical issues occurred. |
| Log Collection Accuracy & Efficiency | |  | | --- | |  | | Excellent | | |  | | --- | |  | | All player actions and scores were logged via JSON structure with no missing or corrupted entries. | |
| Leaderboard Management & Publication | |  | | --- | |  | | Excellent | | Real-time leaderboard was functional and accurate; players could see rankings after each game. |
| Support to Game Designers | |  | | --- | |  | | Excellent | | |  | | --- | |  | | Communication was smooth between developers and content creators; feedback loop functioned well. | |

**Table: Data Collection & Leaderboard Management Effectiveness**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metric** | **Planned Method** | **Actual Method** | **Effectiveness (High/Medium/Low)** | **Comments** |
| Log Collection | JSON-based auto-log via Flask | Manual logging into scores.json | [High] | No data loss occurred; JSON file structured consistently and read accurately. |
| Point Assignment | Predefined score formulas | Formula executed in frontend/backend code | [High] | Scoring was transparent and accurate for all players. |
| Leaderboard Update Frequency | After each game session | After all players completed | [Medium] | Players requested more frequent real-time updates during game flow. |
| Badge Distribution | Manual by facilitator | Manual by facilitator | [Medium] | |  | | --- | |  | | No digital badge system was used; players received verbal feedback. | |

**Overall Feedback:**

* **Effectiveness of Support:**The technical and instructional support provided during the game sessions was highly effective. Game facilitators ensured the smooth operation of timers, scoring mechanisms, and player tracking. All players received clear instructions and assistance as needed.
* **Technical Issues & Solutions:** No technical issues were encountered during the game sessions. The interface functioned smoothly, all buttons and logic executed as expected, and the system remained stable throughout. Real-time supervision ensured uninterrupted gameplay.
* **Data Management Insights:** The use of a structured scores.json file proved very efficient for logging and analyzing performance data. Consistent formatting allowed easy parsing and aggregation for reporting and visualization. This practice should be adopted as a standard for future gamified projects.
* **Suggestions for Future Gamification Team Roles:**

Assign one dedicated *Game Facilitator* per game to manage flow and timer.

Include a *Tech Support* member on standby as a precaution.

Add a *Data Analyst* responsible for exporting and visualizing score and performance metrics after each round.

If possible, involve a *UX Observer* to track player experience and note usability issues for future improvements.

### 6.3. Players' Evaluation

**Checklist: Engagement & Learning Experience (To be completed by players via survey)**

|  |  |  |
| --- | --- | --- |
| **Aspect** | **Rating (Strongly Agree to Strongly Disagree / Yes/No)** | **Comments/Suggestions** |
| The game was engaging and fun. | |  | | --- | | Strongly Agree | |  | | “I didn’t feel like I was learning—just playing, but now I understand sorting!” |
| I understood my role and objectives clearly. | Agree | “The rules were clearly explained with examples at the start.” |
| The game helped me understand. | Agree | “Now I really get what binary search does in fewer steps.” |
| The scoring system was fair and transparent. | Strongly Agree | “It was clear how the scores were calculated; matching ideal swaps made sense.” |
| I felt motivated to perform well in the game. | |  | | --- | | Strongly Agree | |  | | “The leaderboard made me want to do better and be faster.” |
| I would recommend this game to other students. | |  | | --- | | Strongly Agree | |  | | “It’s way more fun than just listening to a lecture. It made algorithms feel real.” |

**Overall Feedback (Aggregated from Player Surveys/Discussions):**

* **What worked well:**

Players found the visual and interactive design of each game highly engaging.

The time-limited structure and clear scoring formulas made objectives clear and

motivated them to perform well.

The leaderboard created a healthy sense of competition that encouraged students to improve their performance.

The step-by-step logic in Selection Sort and the search narrowing in Binary Search were praised for enhancing algorithmic thinking.

* **What could be improved:**

A few players suggested adding a help/hint button during gameplay.

The transition between games could be more seamless with automatic role assignment and guided narration.

* **Perceived Learning:** Students reported that the game significantly improved their understanding of the taught algorithms. They emphasized that playing out the algorithms in a structured scenario helped them internalize how time complexity and decision-making steps operate. Especially for visual and kinesthetic learners, the game was a powerful reinforcement of lecture-based content.

### 6.4. Instructor's Evaluation

**Checklist: Pedagogical Effectiveness (To be completed by instructor)**

|  |  |  |
| --- | --- | --- |
| **Aspect** | **Rating (Excellent/Good/Fair/Poor)** | **Comments/Observations** |
| Achievement of Primary Learning Objectives | Excellent | |  | | --- | |  | | All three algorithm concepts were effectively taught through interactive, time-limited gameplay. Students demonstrated solid understanding of time complexity. | |
| Achievement of Secondary Benefits | Good | Players collaborated, discussed strategies, and showed improvement in analytical thinking and real-time decision-making. |
| Student Engagement Levels | |  | | --- | |  | | Excellent | | All students actively participated and completed their assigned roles. They were motivated and competitive. |
| Game's Integration with Course Material | |  | | --- | |  | | Excellent | | The games were directly aligned with SEN4012 content. Each algorithm was practiced in a meaningful, applied way. |
| Overall Value as a Teaching Tool | |  | | --- | |  | | Excellent | | The gamified structure made difficult concepts more accessible and enjoyable. It enhanced both learning retention and classroom energy. |

**Overall Feedback:**

* **Achievement of Learning Objectives:** The learning objectives were successfully met. Students demonstrated an improved understanding of algorithmic logic, especially in relation to sorting, searching, and greedy approaches. The physical simulation and game-based environment allowed abstract theoretical topics to become more accessible and engaging.
* **Student Understanding:** Students showed a clear grasp of concepts like time complexity, algorithmic steps, and decision-making under constraints. Their ability to apply what they learned in class to real-time game scenarios indicates deep learning and comprehension.
* **Impact on Classroom Dynamics:** The game introduced a fun, collaborative, and competitive spirit into the classroom. Student participation increased, and learners who were previously disengaged became actively involved. Peer support and discussion were observed throughout the gameplay.
* **Recommendations for Future Use:** Gamified methods like this should be integrated more frequently in algorithm and computer science courses. Adding post-game reflection sessions, adaptive difficulty, and mobile versions would increase accessibility and educational value. The current game model could be expanded to cover advanced algorithms such as Quick Sort or Dijkstra’s Algorithm.

## 7. Risks & Mitigation Strategies

This section identifies critical risks for the gamified learning experience, categorized using the Tusler Risk Classification scheme. The definitions for these categories are:

* **Kitten:** Low Probability with Low Impact
* **Puppy:** High probability with low impact
* **Alligator:** Low probability with high impact
* **Tiger:** High probability with high impact

The categories below are applied based on the provided definitions and general project management risk concepts (Project Management Academy, 2025; Tusler, 2006).

**Identified Risks:** [2, 2]

* Misinterpretation of Greedy Algorithm Constraints
  + **Description:** In the Greedy Treasure Hunt game, players may ignore the weight limit while trying to maximize gold, misunderstanding the balance between value and capacity that the greedy algorithm is designed to teach.
  + **Tusler Classification:** **[**Tiger**]** (High Probability with High Impact).
  + **Impact:** Misunderstanding the algorithm’s constraints may result in incorrect application of the greedy strategy in real scenarios, reducing educational effectiveness.
  + **Mitigation:** Introduce visual guidance and post-game analytics to reinforce the importance of weight-gold tradeoffs.
    - **Preventive:** Display a live weight meter with dynamic feedback when nearing the limit.
    - **Responsive:** At the end of the game, show a side-by-side comparison of the player’s path vs. the ideal solution, highlighting what was missed or overloaded.
* Timer Failure During Gameplay
  + **Description:** The countdown timer may malfunction or freeze, especially under browser-based sessions, disrupting timed gameplay in Binary Search or Greedy modes.
  + **Tusler Classification:** **[**Alligator**]** (Low Probability with High Impact)
  + **Impact:** A malfunctioning timer can create unfair conditions, break immersion, and require full session resets, negatively impacting user trust and flow.
  + **Mitigation:** Establish robust fallback mechanisms and test timing scripts across devices and browsers.
    - **Preventive:** Use redundant timer validation checks and simulate stress-tests during QA.
    - **Responsive:** Add a manual reset button for facilitators to restart the timer or resume the session instantly without loss of state.
* Conceptual Misalignment in Binary Search Visualization
  + **Description:** Although students may complete the Binary Search game successfully, the lack of visual range-narrowing may prevent them from fully grasping the divide-and-conquer strategy behind the algorithm.
  + **Tusler Classification:** **[**Puppy**]** (High Probability with Low Impact).
  + **Impact:** Players may achieve high scores without truly understanding the algorithm's core principle, limiting deeper learning.
  + **Mitigation:** Reinforce algorithm logic through interactive visuals and guided steps.
    - **Preventive:** Highlight the active search range in each step using colors or shaded zones.
    - **Responsive:** Provide optional in-game hints and a post-game breakdown of how the range narrowed with each guess.

## 8. Future Enhancements & Iterations

* **Proposed Enhancements:**
* **Dynamic Difficulty Scaling via AI:**  
   Future versions of the project may include simple AI systems that automatically adjust the difficulty level of sorting, searching, and greedy scenarios based on players’ performance. This would keep students challenged without overwhelming them.
* **Player Behavior Classification:**  
   Gamification can be enhanced by tagging student styles—such as "fast solver", "planner", or "trial-and-error explorer"—to better tailor feedback or levels to their approach. This classification can be based on gameplay patterns.
* **Scenario Variations and Events:**  
   New versions of each algorithm game could include branching paths, random events (e.g., time penalty, hint unlock), or layered rounds that require deeper understanding and long-term strategy.
* **Expanded Group Mode:**  
   Currently designed for 3-person groups, future versions can allow for larger collaborative teams (e.g., 4–5 players) with shared scores, cooperative decisions, and multi-role challenges.
* **Log-Based Feedback System:**  
   Automated feedback based on student performance logs can highlight strengths and areas to improve after each game round—helping them reflect on learning progress.
* **Cross-Algorithm Integration:**  
   A new multi-algorithm challenge may combine elements of search, sort, and greedy decisions into a single hybrid game to simulate real-life problem-solving more effectively.
* **Scalability & Replayability:**  
   To serve larger classrooms, the game infrastructure can be optimized to support parallel sessions, multiple role paths, and randomized input datasets so no two games feel the same.

Scalability Plans: Adapt the AI-driven system to support larger groups or multiple parallel games, with the AI managing multiple instances and providing aggregated performance data. 1 In future iterations, the platform can be enhanced to allow multiple groups (e.g., 6+ teams) to play different algorithm games (e.g., Binary Search, Selection Sort, Greedy) at the same time. A shared AI-based monitoring system could automatically track each group’s progress, scores, and performance logs while maintaining isolated session data. This would be especially useful for classroom-wide competitions or lab-based activities with many participants.

Continuous Improvement: After each gameplay session, feedback forms and game logs will be analyzed to understand player decisions, algorithm execution steps, and common errors. These insights will guide improvements in game balance, interface clarity, point distribution, and instructional cues. Future updates will also allow for AI feedback adjustment based on recurring student behavior, making the learning process even more personalized and adaptive.

## 9. Appendices

### Glossary

**Algorithm:**  
 A step-by-step procedure or formula for solving a problem.

**Binary Search:**  
 An efficient algorithm for finding an item in a sorted list by repeatedly dividing the search interval in half.

**Greedy Algorithm:**  
 An algorithmic approach that makes the locally optimal choice at each step with the hope of finding the global optimum.

**Selection Sort:**  
 A sorting algorithm that repeatedly finds the minimum element from the unsorted part and puts it at the beginning.

**Gamification:**  
 The use of game elements in non-game contexts to increase engagement and motivation.

**Leaderboard:**  
 A visual representation of player rankings based on their scores or performance.

**Time Complexity:**  
 A computational complexity that describes the amount of time an algorithm takes to run.

**Player Behavior Classification:**  
 Categorizing players based on their in-game decision-making styles.

**Dynamic Difficulty Scaling:**  
 A game feature that adjusts the challenge level in real time based on player performance.

**Scoring System:**  
 Rules used to calculate points or performance metrics in a game.

## 10. Conclusion

# This comprehensive post-game project report documents the development, implementation, and evaluation of the *Learning Algorithms With Games* project—an educational initiative designed to teach fundamental algorithmic concepts through gamified digital experiences. The project effectively integrated physical interaction with digital gameplay to support enhanced student engagement and learning outcomes, specifically within the scope of algorithms such as Selection Sort, Binary Search, and the Greedy Algorithm.

# By clearly defining roles (Sorters, Searchers, Hunters), establishing distinct game flows and scenarios, and applying a robust scoring and leaderboard system based on individual and group performance, the project created a structured yet dynamic learning environment.

# The gamified structure empowered students to engage with complex algorithmic logic in an intuitive, interactive format. Moreover, group-based score averaging encouraged teamwork while maintaining individual responsibility. This dual-layered assessment approach supported both collaborative learning and competitive motivation.

# Ultimately, the project achieved its main goal: teaching algorithmic thinking through gamification. By transforming algorithms into interactive games, students were able to learn core concepts like sorting, searching, and greedy strategies in a fun and engaging way. This helped make abstract topics more understandable and memorable.

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