# Big 2 Mobile Companion Application Report

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## 1. Abstract

This study delivers a mobile application designed to facilitate the process of playing the card game *Big 2*. Players are provided with a simplified interface for referencing valid moves, track game progression, and reducing cognitive load. The primary design goal was to enhance usability and memory recall without compromising the game's social or strategic elements. The application's interface was evaluated against a basic spreadsheet tool currently used for score tracking. Eight participants completed a set of tasks using both interfaces, with quantitative data analyzed using ANOVA, while qualitative feedback was assessed through thematic analysis. Results suggest that, within the scope of the experiment, the companion app performs on par with the existing method in terms of efficiency. However, users reported feeling significantly more confident and engaged while using the app. These preliminary findings support the potential of mobile companion tools to enhance player experience in casual, face-to-face gaming environments.

## 2. Introduction

Mobile interfaces are increasingly used not just for fully automated digital games but also as **companion tools** to support traditional in-person gameplay. In informal, memory-heavy card games like *Big 2*, players are expected to keep track of previously played cards and current round progression without assistance. This often leads to confusion and impacts strategic decision-making, especially among casual players.

As mobile devices become more integrated into social settings, there is an opportunity to design **non-intrusive mobile companions** that enhance gameplay without replacing it. By focusing on a lightweight and supportive UI, such tools can preserve the **tactile and social nature** of physical card games while reducing player frustration.

### 2.1 Problem Statement

Players of Big 2 often struggle with tracking previously played cards and remembering each player's moves, especially over longer rounds. This not only creates a cognitive burden but can lead to disputes or confusion during the game. Current mobile card game solutions either fully digitize gameplay or lack features tailored to supporting live, in-person games. There is a lack of tools that assist players in real-time without automating the entire experience.

### 2.2 Objectives

- Design and develop a mobile companion app that supports players in tracking cards and player actions during Big 2.
- Evaluate the usability and effectiveness of the application in improving memory retention and gameplay experience in comparison to a pre-established dated method.
- Explore the potential of mobile tools to enhance social, in-person games without disrupting gameplay dynamics.

### 2.3 Hypothesis

We hypothesize that players using the Big 2 companion app will experience **reduced cognitive load** and **fewer memory-based mistakes**, leading to **greater overall satisfaction** during gameplay.

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## 3. Related Work

As a guide to informing our design and implementation, we referenced several research papers and existing applications on card game trackers, mobile UI, and performance. Below are four of our most important references:

1. ***Usability in Mobile Card Games* -** Mobile card game research places high emphasis on the need for clear UI/UX design to optimize player engagement. Studies indicate that touch responsiveness, visual feedback, and responsive layouts enhance user experience in mobile game applications. Well thought out UI components, such as drag-and-drop gameplay and gesture-based navigation, significantly improve usability and accessibility for players of varying levels of proficiency.

2. ***Performance Considerations in Multiplayer Games*** – Real-time multiplayer mobile games face challenges such as latency, synchronization, and data consistency. Prior work explores methods to minimize server-client latency and optimize data transmission for mobile multiplayer games. Findings suggest that implementing predictive synchronization algorithms can improve game fluidity, particularly in card games where quick decision-making is crucial

3. ***Energy Consumption in Mobile Gaming*** – Studies indicate that high processing demands in mobile games lead to battery overconsumption, reducing the device's efficiency. Literature recognizes frame rate control, efficient rendering, and intelligent background processing as techniques to extend battery life in mobile applications. Implementation of these power-reduction techniques can increase the longevity of gaming sessions with no compromise on the user experience

4. ***Automated Payment Systems in Gaming*** – Researchers have explored digital payment integration in mobile games in the context of microtransactions and in-game economies. It is explained how automated payout systems enhance user convenience and prevent calculation errors in game transactions. This research will be incorporated into the *Big 2* mobile app to offer seamless, accurate, and secure payout calculations from game outcomes

These studies underscore the importance of usability, performance, energy, as well as automated payments. This will guide our design and evaluation process.

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## 4. Methodology

The project followed a structured methodology to ensure a comprehensive evaluation of the app's usability and preference when conducting interaction analysis between two user interfaces.

### 4.1 Participants

Eight participants were recruited through convenience sampling from a researcher's pool of acquaintances, and were asked to complete a consent form and demographic survey. The sample consisted of four female and four male participants, ranging in age from 18 to 25. On

average, participants were familiar with mobile application use, reporting 0-1 hours of daily mobile gaming and 4-5 hours of daily general mobile use. Experience with *Big 2*, including its rules and scoring system, was evenly split: four participants were considered experts, while four participants had no prior experience. Participants were also asked about their experience using Excel on mobile devices; the majority indicated familiarity only with the desktop version. Although no strict requirement criteria were imposed during recruitment, efforts were made to ensure a balanced participant demographic.

### 4.2 Apparatus

The current solution relies on an Excel spreadsheet to store player information and game scores. Each individual game is stored on a separate spreadsheet file, so the user has to duplicate and rename all relevant fields every time a new game session is started. In every spreadsheet, a base table is utilized to keep round-by-round scores, with a row for every round, and a summary row at the end of the base table that tallies the sum scores for every player. On the side of this table, there is room for calculating payouts. The amounts are according to a user-defined card value, which acts as a multiplier for the overall scores from the game table.

### 4.3 Procedure

Participants performed a set of 22 tasks designed to evaluate the navigation and input capabilities of the Big 2 Companion App. These tasks include creating new games, inputting score rounds, modifying titles, player names, and card values, as well as deleting, resetting, and finishing rounds.This would be followed by a second task set, in which participants completed the same 22 tasks using the Excel app, which is the current application used to track scores.

To ensure counterbalancing, participants were sorted into two groups. Group A performed the tasks on the companion app first, followed by Excel; Group B completed the tasks in reverse order. In between each task set, participants completed a short survey to provide qualitative feedback about the app they had just used. The survey included questions related to general usability, perceived difficulty, energy use, and user preferences (Appendix A.3). At the conclusion of the experiment, participants answered a final questionnaire comparing the two methods, with their reasons recorded.

### 4.4 Design

The independent variables in this experiment were interface, expertise, and task order. Interface was a two-level within-subjects factor comparing the user interface of *Big 2 Companion App* and Excel. Expertise was a two-level between-subject factor, based on participant's familiarity with the game: experienced players versus novices . Order was also a 2-level between-subjects factor, reflecting the counterbalancing method described in section 3.3, in which participants were assigned to either complete tasks on the app or Excel first.

The dependent variables in this study were usability, performance, and user preference. Usability will be evaluated through task accuracy and completion time.  Performance was measured using Android Studio's profiling tool. User preference was assessed through qualitative data gathered from post-task and final surveys.

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## 5. Implementation

The app is built on an MVVM (Model-View-ViewModel) architecture, with a separation between the data logic and user interface for scalability and maintainability.

### 5.1 Back-End

The back-end uses RoomDB for storing data locally, defined in AppDatabase.java. It is structured in three major layers:

- **Entities** define data models for two tables: Games and Rounds.
- **DAOs** provide methods for accessing the database.
- **Repositories** manage data transactions and serve as a bridge between the DAOs and ViewModels.
- **ViewModels** make it possible for UI components to be notified and react to data changes in a lifecycle-aware manner.

Games table contains metadata like game name, players' names, total score, card value, and whether the game is completed or not. Rounds table points to a game using a foreign key and maintains the players' scores on a per-round basis.

### 5.2 Front-End

Front-end consists of four major activities:

- **Select Game Activity** displays a list of games via a RecyclerView, with game status filters. The user may delete games or proceed to the next applicable screen based on game state.
- **Gameplay Activity** is the main play interface. It displays player rankings, scores, round details, and turn order. Number pickers (0–13) are utilized to enter scores, with one of the players being required to have a score of zero by rule. Navigation to summary and rules is also present on the screen.
- **Game Summary Activity** presents all rounds in a table format. Metadata editing (title, player names, card value) or game reset if unfinished is permitted. Scores are converted to monetary values based on the card value multiplier.
- **Rules Activity** utilizes a horizontal RecyclerView to divide the rules into six categories. Each card opens a detailed view with navigation controls for convenient access.

### 5.3 Key Features and Interaction

The application is centered around intuitive play and efficient game tracking. Number pickers allow for rapid round entry, and player rankings are updated dynamically to place the current leader at the far left for visibility. Assistive graphics—turn indicators, suit order, and sample hands—help new players learn game mechanics without leaving the screen.

### 5.4 Tools and Technologies

The application was developed with Java in Android Studio, utilizing its emulator, layout editor, and profiling tools to provide a smooth and user-friendly interface.

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### 6.1 Quantitative Analysis of Results

The quantitative data obtained from each participant was analyzed using the *Go.Stats.jar* program authored by York University processor Scott McKenzie (MacKenzie, 2023). This program contains ANOVA (Analysis of Variance) GUI tool, which was utilized to conduct statistical and interaction analysis. The following inputs were used within ANOVA for this

study: one two-level within-subjects factor and two two-level between-subject factors. Task error rate was calculated by the following formula: (# of task completed successfully) / 22) * 100. Each participant's task time for both interfaces were converted to seconds in the format (s.ss, s.ss). Both metrics compile all participant's data into their own .txt files and were inputted into ANOVA.

### 6.1.1 ANOVA Results

Overall, the effect of interface, expertise and task order on error rate and completion time were not statistically significant (Appendix A.5), as the p-value were greater than 0.05., The p-value represents the probability that observed differences occurred by chance, and a value above 0.05 suggests that any differences in this experiment are not meaningful. Because of this lack of statistical significance, further post-hoc analysis was not necessary.

The lack of statistical significance for task order is a positive outcome, as it indicated that the counterbalancing was effective. Similarly, the non-significant result for experience suggests that both the *Big 2 Companion App* and Excel have comparable learnability. This implies that both applications are equally accessible to newcomers and experienced users alike, when compared to each other. Lastly, the lack of statistical significance for interface effect implies that both apps perform similarly in terms of task completion—neither one is objectively better at helping the user accomplish this particular set of instructions outlined in this experiment.

### 6.1.2 Performance results

Battery depletion rates remained consistent among both interfaces, as observed during the experiment. As a result, ANOVA was not utilized to analyze this metric. All participants experienced a 2% battery decrease while using the companion app, and 1% for Excel.

Additional testing showed that the companion app consumed approximately 1% of the battery every 5 minutes, while Excel consumed 1% every 15 minutes. One outlier was observed during the companion app's usage, where a completion time of 4 minutes and 35 seconds resulted in a 1% battery drop. The longest recorded session using the app lasted 12 minutes and 29 seconds, resulting in a 2% battery drain. In comparison, Excel's longest session was

11 minutes and 47 seconds, which resulted in a 1% battery drain. These findings align with the participants' data.

### 6.2 Qualitative Analysis of Results

To better understand participants' experiences and preferences with the Big 2 Score Tracker app and its spreadsheet counterpart, a thematic analysis of open-ended survey responses was conducted. Using open and axial coding, several key themes emerged, highlighting how interface design, error handling, user expertise, and interaction style shaped the overall usability experience.

### 6.2 Thematic Findings

#### 6.2.1 Interface Fluidity and Gameplay Integration

Participants consistently described the mobile app as more intuitive, visually appealing, and well-integrated into the flow of gameplay. Several users found the app "fun" and "themed," highlighting its ability to enhance engagement in social settings. Its layout and real-time feedback allowed users to complete tasks more efficiently and with fewer distractions compared to the spreadsheet.

In contrast, the spreadsheet was perceived as functional but less fluid, especially on mobile devices. Although it offered transparency in logic and structure, users—particularly non-experts—found it more prone to disruptions due to the need for manual data entry and the potential to accidentally break formulas or disrupt layouts.

#### 6.2.2 Error Recovery and System Resilience

Error handling emerged as a central factor in user satisfaction. The app's constrained workflow and built-in safeguards minimized user mistakes and made recovery intuitive. The spreadsheet, by contrast, allowed unrestricted inputs, increasing the likelihood of accidental changes.

Non-experts, in particular, reported incidents such as deleting rows or altering formulas, leading to miscalculations and difficulty navigating the interface. The absence of an undo mechanism and the lack of visibility into formula logic intensified these challenges.

#### 6.2.3 Role of Expertise in Navigation Strategy

Expert users demonstrated proficiency with both interfaces. They completed tasks efficiently and used the spreadsheet's flexibility to conduct in-depth review and scoring adjustments.

Their feedback focused on enhancing workflow efficiency, such as integrating visual grouping and shortcut features.
Non-expert users overwhelmingly favored the mobile app. They cited its simplicity, clearly defined workflows, and reduced risk of error as major advantages. The app's limited action scope provided a sense of safety and confidence, contrasting with the open-ended nature of spreadsheet input.

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**7. Limitations & Future Work**

The study involved only eight participants, all recruited through convenience sampling. This small, homogenous sample limits the generalizability of findings. Broader demographic representation, including older users and those with varying levels of digital literacy, would provide a more comprehensive understanding of usability across user populations. In addition, the task-based evaluation was conducted in a controlled environment rather than during actual gameplay, which may not fully capture natural user interactions and social dynamics. Although task order was counterbalanced, potential learning effects may have influenced participant performance across interfaces. Furthermore, the app was designed specifically for Big 2, which limits its applicability to other games. Participants also recommended improvements such as audio cues, onboarding tutorials, and clearer button layouts to enhance the first-time user experience.

Future work should focus on expanding the app’s scope to include support for other card or tabletop games through a modular or customizable scoring interface. Real-world field testing over longer periods would help evaluate the app's sustained usefulness. Additional features such as collaborative scorekeeping, user profiles, accessibility options, and adaptive interfaces based on player expertise could significantly improve usability and broaden adoption.

**8. Conclusion**

This project explored the use of a mobile companion app to support live Big 2 gameplay by reducing cognitive load and improving score tracking. While both solutions have been shown to equally assist with gameplay, the app offered a structured, intuitive alternative to

traditional spreadsheet tracking. Usability testing showed that the app was easier to use, and less error-prone, especially for non-experts, however, there are still potential improvements that can be made to the app, such as battery optimization or any other additional features that may help enhance usability. Although based on a small sample, these findings support the potential for mobile companion apps to enhance in-person games.

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**9. References**


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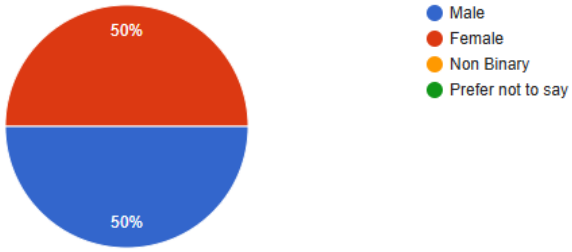
# Appendix

## A.1 Participant Demographic Data

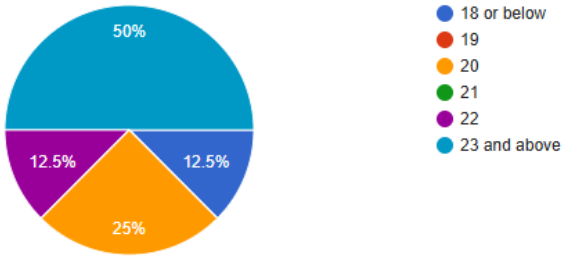
What gender do you identify with?

8 responses



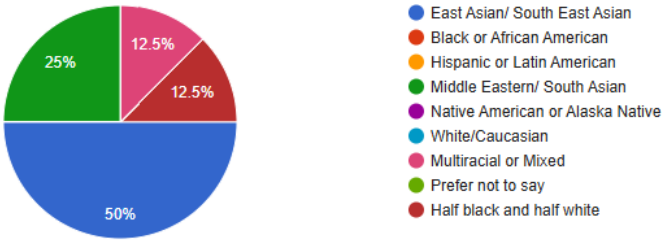

What is your age?

8 responses



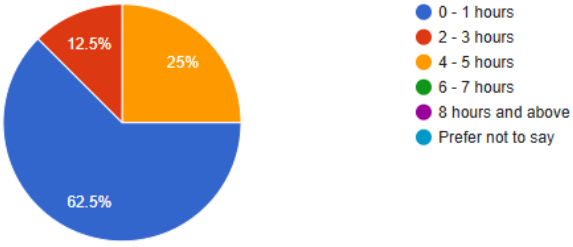

Which of the following best describes your ethnicity?

8 responses



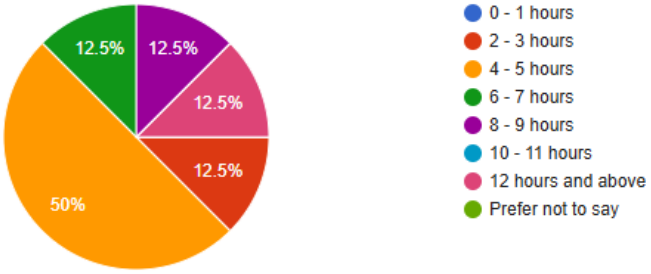

**Experience with mobile apps:** How many hours per day on average do you spend on mobile game apps?

8 responses



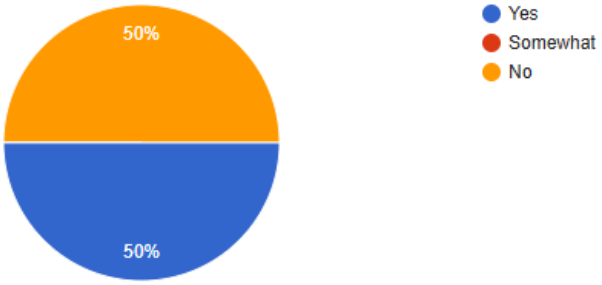
**Experience with mobile devices:** How many hours per day on average do you spend using a mobile device?

8 responses



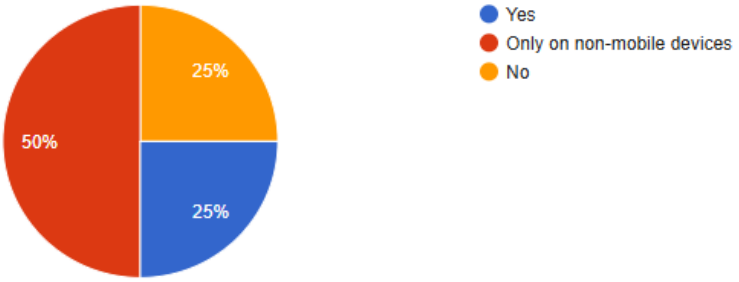

**Experience with Big 2 Card Game:** Do you consider yourself familiar with Big 2's gameplay and rules?

8 responses




**Experience with Excel:** Do you consider yourself familiar with navigating an Excel spreadsheet on a mobile device?

8 responses



## A.2 Experiment Tasks

- ☐ (1) Create 3 Games (First one you create will be Game 1, Next is Game 2, etc)
- ☐ **(2)** Input 3 Rounds of scores for **Game 1** *(You should be on **Round 4** before moving on)*
- ☐ **(3)** Change the Title and at least 1 player's name and Card Value ($) for **Game 1**
- ☐ **(4)** Input 1 more Round of scores for **Game 1**
- ☐ **(5)** Change the Score of 1 round in **Game 1**
- ☐ **(6)** Delete any individual round from **Game 1**
- ☐ **(7)** Finish **Game 1**
- ☐ **(8)** Input 2 Rounds of scores for **Game 3**
- ☐ **(9)** Delete **Game 2**
- ☐ **(10)** Reset **Game 3**
- ☐ **(11)** Change the Title for **Game 3**
- ☐ **(12)** Input 3 Rounds of scores for **Game 3**
- ☐ **(13)** Finish **Game 3**
- ☐ **(14)** Create **Game 4**
- ☐ **(15)** Continue **Game 3**
- ☐ **(16)** Input 2 Rounds of scores for **Game 3**
- ☐ **(17)** Change the Card Value ($) for **Game 1**
- ☐ **(18)** Input 1 Round of scores for **Game 4**
- ☐ **(19)** Change the Score of that round in **Game 4**
- ☐ **(20)** Delete **Game 4**
- ☐ **(21)** Delete a Round for **Game 3**
- ☐ **(22)** Finish **Game 3**

Total: 22

- Select Game Activity: /4
- Gameplay Activity: /6
- Game Summary Activity: /12

*Participants will do this portion first if they are not familiar with Big 2. Otherwise, do this second.*

- View the rules page on the app
- View the poker hands on the app

## A.3 Survey Questions

**A. General Usability Questions:**

1. On a scale of 1-5, how easy was it to learn how to use the app?
   (1 = Very Difficult, 5 = Very Easy)
2. On a scale of 1-5, how intuitive did you find the navigation of the app?
   (1 = Not Intuitive at All, 5 = Very Intuitive)
3. How satisfied were you with the overall performance of the app?
   (1 = Very Unsatisfied, 5 = Very Satisfied)
4. How responsive was the app during your interactions?
   (1 = Very Slow, 5 = Very Fast)

**B. Task-Specific Questions (based on specific tasks users performed):**

1. How easy was it to complete the task you were assigned?
   (1 = Very Difficult, 5 = Very Easy)
2. Did you encounter any errors or difficulties while performing the task?
   (Yes/No). If yes, please describe, briefly, what went wrong.
3. How comfortable were you performing the task using one hand vs. two hands?
   (1 = Very Uncomfortable, 5 = Very Comfortable)
1. The navigation method helped your ability to complete the task efficiently
   (1 = Strongly Disagree, 5 = Strongly Agree)

**C. Energy and Performance Questions:**

1. Did you notice any lag or delay in the app's performance during the task?
   (Yes/No)
2. Did you notice the app using excessive battery power during the task?
   (Yes/No)
3. How would you rate the overall energy efficiency of the app?
   (1 = Very Inefficient, 5 = Very Efficient)

**D. User Preferences:**

1. Would you suggest any improvements to the interface?
   (Open-ended response)
2. Which interaction method (one-handed or two-handed) did you prefer?
   (One-handed, Two-handed)

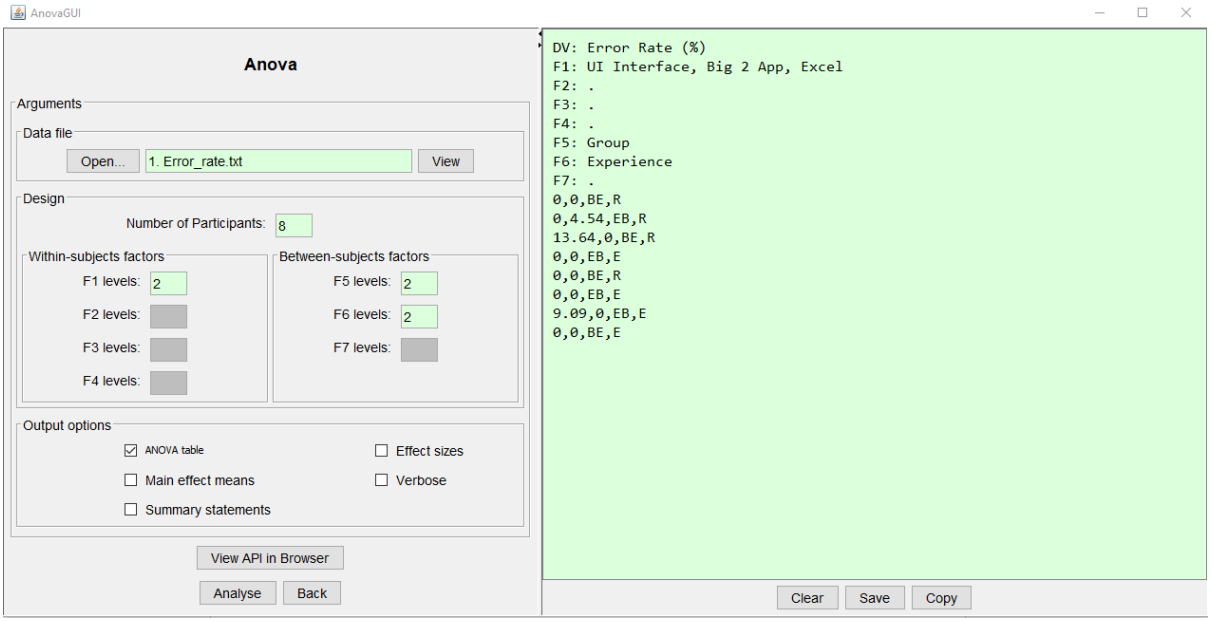
**E. Overall Satisfaction:**

1. How satisfied were you with the overall user experience?
   (1 = Very Unsatisfied, 5 = Very Satisfied)

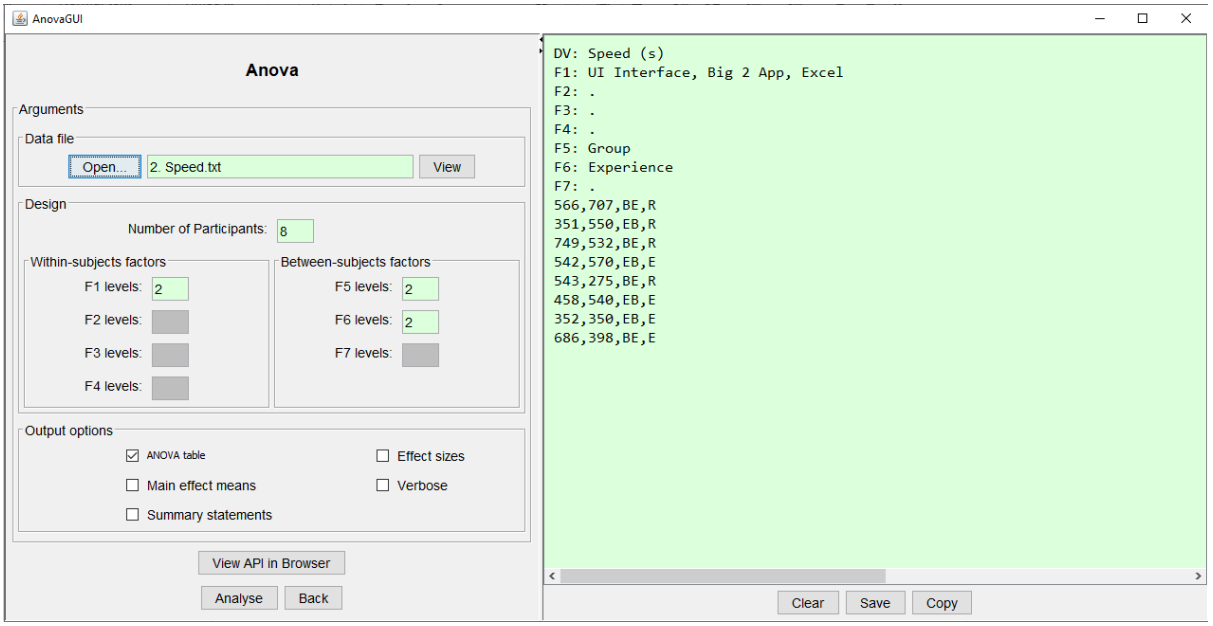
**Final 1:** After testing both the app and spreadsheet out, what would you prefer to use to play big 2? (I will not take offense to your opinion, I am looking for purely objective points of view on this)

**Final 2:** I would like a detailed description as to why you feel this way. Feel free to make it as descriptive as possible.

## A.4 Analysis Artifacts - ANOVA Data Input




*ANOVA GUI with error_rate.txt data*




*ANOVA GUI with speed.txt data*

## A.5 Analysis Artifacts - ANOVA Results

```
ANOVA_table_for_Error Rate (%)
================================================================================
Effect                         df        SS            MS         F        p
--------------------------------------------------------------------------------
Group                           1         0.000         0.000     0.000    0.9995
Experience                      1        46.478        46.478     3.597    0.1308
Group_x_Experience              1         0.000         0.000     0.000    0.9995
Participant(group)              4        51.688        12.922
UI Interface                    1        20.680        20.680     0.890    0.3989
UI Interface_x_Group            1         5.164         5.164     0.222    0.6619
UI Interface_x_Experience       1        20.680        20.680     0.890    0.3989
UI Interface_x_Group_x_Exper    1         5.164         5.164     0.222    0.6619
UI Interface_x_P(group)         4        92.957        23.239
================================================================================
Data_file: 1. Error_rate.txt

Summary statements:
The effect of group on error rate was not statistically significant (F(1, 4) = 0.000, ns).
The effect of experience on error rate was not statistically significant (F(1, 4) = 3.597, p > .05).
The group_x_experience interaction effect was not statistically significant (F(1, 4) = 0.000, ns).
The effect of ui interface on error rate was not statistically significant (F(1, 4) = 0.890, ns).
The ui interface_x_group interaction effect was not statistically significant (F(1, 4) = 0.222, ns).
The ui interface_x_experience interaction effect was not statistically significant (F(1, 4) = 0.890, ns).
```

*error_rate.txt Statistical Significance Outcome*

```
ANOVA_table_for_Speed (s)
================================================================================
Effect                         df         SS            MS         F        p
--------------------------------------------------------------------------------
Group                           1     34503.063     34503.063     1.824    0.2482
Experience                      1     36576.563     36576.563     1.933    0.2368
Group_x_Experience              1      3875.063      3875.063     0.205    0.6743
Participant(group)              4     75671.750     18917.938
UI Interface                    1      6601.563      6601.563     0.459    0.5351
UI Interface_x_Group            1     55107.563     55107.563     3.834    0.1218
UI Interface_x_Experience       1      3937.563      3937.563     0.274    0.6283
UI Interface_x_Group_x_Exper    1     11289.063     11289.063     0.785    0.4255
UI Interface_x_P(group)         4     57489.750     14372.438
================================================================================
Data_file: 2. Speed.txt

Summary statements:
The effect of group on speed was not statistically significant (F(1, 4) = 1.824, p > .05).
The effect of experience on speed was not statistically significant (F(1, 4) = 1.933, p > .05).
The group_x_experience interaction effect was not statistically significant (F(1, 4) = 0.205, ns).
The effect of ui interface on speed was not statistically significant (F(1, 4) = 0.459, ns).
The ui interface_x_group interaction effect was not statistically significant (F(1, 4) = 3.834, p > .05).
The ui interface_x_experience interaction effect was not statistically significant (F(1, 4) = 0.274, ns).
```

*speed.txt Statistical Significance Outcome*