



**CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY**

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Project Title Game Theory: Which Chess Move in Response to White's 1. e4 Maximizes Black's Outcome?	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This project relates to a branch of science known as "combinatorial game theory." The objective of this experiment was to test my hypothesis: If e5 (pawn to king five) is played as the Black player's first move in response to White's first move of e4, then Black will be provided with the greatest possible initial advantage and thereby yield a greater percentage of wins for Black than other replies.</p> <p>Methods/Materials First, I determined 1. e4 was the most common opening move for White and therefore, arguably, the "best" move for White. Since e5 is symmetrical to e4 and has the same advantages, then 1...e5 could be considered the best response to e4. PHASE I - Database Analysis to Determine the Historically "Best" Reply: I used the "industry standard" ChessBase 8.0 which is a database of 1.8+ million chess games to perform statistical analysis of the responses given to 1. e4. Thus, I determined which moves for Black yielded the best outcome and then proceeded to Phase II. PHASE II - Modeling and Simulation to Validate Database Results: I programmed Chessmaster 9000 to play a series of 100 two-minute games against itself for each of the three Black moves selected from Phase I: 1...e5, 1...c5 and 1...g6. I used the computer to play itself in order to reduce the variables that could be factors when two human opponents play. These variables include: players of different strengths and various physical and psychological factors. With the computer playing itself, each "player" would be of equal strength, hence the initial opening moves would be the largest factor in determining the outcome.</p> <p>Results The results from Phase I (Database Analysis) indicated that 1...c5 was the best move (49%), followed by 1...g6 (48%), and then followed by 1...e5 (44%). The results from the Phase II (Database Validation) computer-versus-computer trials analysis confirmed that 1...c5 was still the best move (46.5%) followed by 1...g6 (45.5%) and then 1...e5 (42.5%).</p> <p>Conclusions/Discussion Although the scoring percentages differed somewhat between Phase I and Phase II results, the rank order and magnitude of effectiveness against 1. e4 remained essentially the same. Therefore, the information collected from my experiment indicates that my hypothesis is incorrect, and that in fact 1...c5 (not 1...e5) is the best response to the White opening move 1. e4.</p>	
Summary Statement My experiment is about combinatorial game theory as it relates to modern chess opening theory.	
Help Received My parents helped purchase all project materials, and my mother helped edit my report.	