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USING CHESS TECHNOLOGY TO TEACH CHESS TO UNIVERSITY STUDENTS AND TO RESEARCH CHESS

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Abstract

The purpose of this article is to describe and illustrate the utility of chess technology is in teaching chess to university students and to investigate chess among chess engines and human chess players. This article has two sections. The first section describes and illustrates how chess technology can be used to teach chess to university undergraduates. The second section explains and illustrates how chess technology can be used to investigate chess among chess engines and human chess players. The first section provides numerous cases of chess-related websites such as chess.com, lichess.org, and chessgames.com that have been used and can be used in teaching chess to university students. The second section provides two examples of research as to how chess technology can be used in research on chess. One line of inquiry dealt with the extent to which the disparity in chess skill between two chess engines is related to the length of a chess game. A second line of inquiry dealt with the relationship among chess game blunders, parts of chess games that blunders occur, and levels of chess skills among the chess players that are chess engines. There are many chess engines at varying chess skill levels that are readily available on chess-related websites for research on chess. Chess technology has substantial utility in teaching chess to university students and in investigating chess as a field of study.

Keywords: Chess technology, chess engines, chess training, chess research, blunder analysis, university courses, chess-related websites, thinking skills

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Using Chess Technology to Teach Chess to University Students and to Research Chess

The purpose of this article is to describe and illustrate the utility of chess technology is in teaching chess to university students and to investigate chess among chess engines and human chess players. Some definitions will clarify the meaning of the terms "chess technology" and "chess engines". Chess technology refers to the array of chess-related websites such as chess.com and lichess.org, chess-related apps such as Play Magnus available on an IPhone, and chess software such as Fritz 17 and Deep Shredder used by members of the international chess community.

An additional definition will be useful. A chess engine is chess software that can play a game of chess. Fritz 17, Deep Shredder, and Stockfish that is used in chess.com and lichess.org are examples of chess engines.

This article has two sections. The first section describes and illustrates how chess technology can be used to teach chess to university undergraduates. The second section explains and illustrates how chess technology can be used to investigate chess among chess engines and human chess players.

The Utility of Chess Technology in Teaching Chess to University Students

Bart (2021) reported on his experiences in using chess technology in teaching chess to university students. This section will review that report with additional commentary on how chess technology was used in teaching chess.

To explore the effects of chess instruction on university undergraduate students, 10 offerings of a Freshman Seminar entitled "Beginners' Chess and 21st Century Thinking Skills" were implemented and examined at the University of Minnesota, a large state university in the U.S.A. The motivation for the university course was the belief that chess training can facilitate the development of 21st Century thinking skills among undergraduate students. Many undergraduate students lack 21st Century thinking skills. Chess requires 21st Century thinking skills such as skills at creative thinking, critical thinking, decision making, planning, and problem solving.

Participants

The students enrolled in the Freshman Seminar were first-year and second-year undergraduate students. The students tended to have little or no knowledge of chess prior to the course. The Freshman Seminar had 10-20 students in each annual offering of the course that lasted 15 weeks. Thus, there were approximately 150 participants in the study.

Instruments

The university Student Ratings of Teaching (SRT) questionnaire was the instrument that served as the course evaluation questionnaire. This instrument was used to assess the quality of teaching in a course, not the quality of the course content. The SRT questionnaire included five items: (1) I have a deeper understanding of the subject matter as a result of this course; (2) My

interest in the subject matter was stimulated by this course; (3) Instructional technology employed in this course was effective; (4) The grading standards for this course were clear; and (5) I would recommend this course to other students. A 6-point Likert-style was used for student responses. The options were as follows: 1 = not applicable, 2 = strongly disagree, 3 = Disagree, 4 = Somewhat disagree, 5 = Agree, 6 = Strongly agree.

A secondary instrument was the final reflection paper that the students prepared and in which they indicated what they liked about the course and what ways, if any, the course helped to improve their thinking skills.

Procedure: The course made extensive use of chess-related websites available on the Internet such as chess.com, lichess.org, and chessgames.com. The instruction involved the projection of a chess-related website projected onto a large classroom screen with the use of an instructor's computer connected to a projector that projected the computer-based image onto the screen. The chessboards available on chess.com and lichess.org were especially useful in the class instruction, as they were clear to the students and permitted the movement of pieces on the chessboard. The instructor of chess was able to illustrate many concepts and ideas in chess such as castling and checkmate withthe use of those web-based images. The board editor on lichess.org was used often to illustrate chess concepts (https://lichess.org/editor?fen=8%2F8%2F8%2F8%2F8%2F8%2F8%2F8+w+-+-+0+1.

After the students received a set of introductory lessons, students would play chess games with each other with the use of either the computers available near their seats or physical chess sets that they would bring to class. The students tended to play chess games with each other with the use of the computers located on the tables near their seats or against chess engines available either on chess.com or lichess.org.

The chess engines on those two websites, chess.com and lichess.org, range in difficulty from easy to very difficult. For example, there are eight chess engines available on lichess.org ranging from chess engine 1 being the easiest to chess engine 8 being the most difficult. Students were encouraged to play chess first against an easy chess engine such as chess engine 1 on lichess.org before proceeding to play against a more difficult artificial opponent such as chess engine 2 on lichess.org. Also, students were encouraged to defeat a chess engine twice, once with the White pieces and once with the Black pieces, before playing against a chess engine with a higher level of difficulty.

The course entailed 15 course lessons with each course lesson being 2.75 hours in length. There was one course lesson per week for 15 weeks. The early lessons made use of the United States Chess Federation website termed "New to Chess?" (www.uschess.org/index.php/New-to-Chess-/) that provides the basic rules of chess. The course involved instruction in chess on topics such as tactics and basic checkmates along with instruction on the cognitive psychological foundations of chess on topics such as critical thinking and problem solving.

After basic concepts in chess were taught, the instructor introduced students to basic chess openings such as the Ruy Lopez and classic chess games such as the 1858 Opera Game with Paul Morphy playing the White pieces with the use of the chessgames.com website (https://www.chessgames.com). Undergraduates tended to enjoy using computers and viewing chess-related websites freely available on the Internet.

The primary task in the course was that each student had to prepare a critical evaluation of two of their own chess games that included correct usage of proper algebraic notation for the chess moves. In addition to the critical evaluations of two of their personal chess games, the students also were asked to prepare final evaluation reports. The students were awarded course points for their completed final evaluation papers.

Results

An analysis of the SRT responses indicated that the students thoroughly enjoyed the course. The SRT rating score means tended to be in the high 5-6 range. In many of the final reflection papers for each offering, students attested that their thinking skills improved as a result of the course.

The students tended to be quite competitive. They wanted to play chess games with each other during class. They tended to get along and enjoyed the class environment. The instructor celebrated good moves made by students. The instructor indicated that all chess players inevitably lose games. The students accepted the emphasis on personal growth in chess rather than winning games at all cost.

The activity most enjoyed by the students was team competition. The students would be subdivided into two teams (e.g., an East team and a West team). The teams would play chess against each other with members of each team taking turns making a move. Members on a team were allowed to offer advice to the team member making the move.

The instructor would enter each move on the instructor's computer and project the game on a large classroom screen with use of the chess.com game board so that the entire class would be able to see the game. The instructor would serve as the impartial referee and would comment periodically on the game positions. The instructor set a time limit of 2 minutes for each move.

The students tended to become very excited during these team games. Active student engagement was a major characteristic of the course.

Conclusions and Recommendations

Five recommendations emanate from this inquiry. One, universities and colleges worldwide should provide chess training to students in their institutions. Many undergraduate students lack the reasoning skills fostered in chess instruction. The cognitive skills developed in chess would likely benefit undergraduates in their other university or college coursework. Among the cognitive skills that chess develops are skills at decision making, problem solving,

planning, critical thinking, and even creative thinking. Those cognitive skills are valued and useful in undergraduate educational settings and in professional life.

Two, chess instruction for university students should involve team competition. Undergraduates tended to be very competitive and social. An instructor of chess for undergraduates may have one group of students play chess against another group of students with students in both groups taking turns making moves. Students tend to enjoy such games as they learn how to work together. Chess instruction can help undergraduate students learn to work cooperatively to achieve certain goals. Such capacity to form teams to work cooperatively and harmoniously is another attribute highly valued in many professions.

Three, the chess instruction should make extensive usage of computer technology and computer-based websites. Chess instruction for chess beginners or chess novices is relatively uncommon, but, with the host of chess-related websites and computer-based technology, the time has come for chess instruction in collegiate and university settings in order to facilitate the development in undergraduate students of higher order 21st Century thinking skills such as skills at critical thinking, decision making, planning, and problem solving. Those higher order thinking skills are required in order to play chess at even an intermediate level of chess competency. Many undergraduate students lack those higher order thinking skills.

Four, there should be research on the mental health benefits of chess instruction. Undergraduates can be under stress in colleges and universities as they attempt to complete courses of instruction in a timely and successful manner. Learning and then playing chess can be a form of recreation and relaxation that can lead to a reduction in stress for the undergraduate students. Learning and playing chess can even be enjoyable to undergraduates that can then account for the widespread interest and motivation that many chess players have for playing chess.

Five, chess instruction for chess beginners or chess novices is relatively uncommon, but, with the host of chess-related websites and computer-based technology, the time has come for chess instruction in collegiate and university settings in order to facilitate the development in undergraduate students of higher order 21st Century thinking skills such as skills at critical thinking, decision making, planning, and problem solving. Those higher order thinking skills are required in order to play chess at even an intermediate level of chess competency. Many undergraduate students lack those higher order thinking skills.

Chess instruction is typically oriented toward school-aged children (e.g., Capablanca, 1994; Coakley, 2000; Sadler, 1999; Schloss, 2014; Seirawan, 2003; Stean, 2002; Weeramantry & Eusebi, 1993; Wilson, F. 1994). No books were available specifically for teaching chess to university undergraduate students. Also. no books were available specifically for undergraduate university students to learn chess. Using chess technology compensates for the paucity of pertinent books and pamphlets in teaching chess to university students.

In addition, chess instruction often relies on a human instructor using a large demonstration board with chess pieces that can be moved about by the instructor on squares on the large board. In such a case, students often have access to chess sets with chess pieces and chessboards with which they practice chess maneuvers. Also, students use the physical chess sets to play chess. Chess technology can compensate for the lack of chess knowledge among chess instructors available to teach chess to undergraduates.

In conclusion, chess instruction in colleges and universities has substantial potential to enhance and enrich the education of undergraduate students.

The Utility of Chess Technology in Research on Chess

Chess websites such as chess.com and lichess.org use chess engines such as Stockfish 13 or Stockfish 14. Chess.com employs an array of chess engines, ranging from chess engine 1 to chess engine 25. The chess engines 1-24 are weakened versions of Stockfish 14. lichess.org also employs an array of chess engines, ranging from chess engine 1 to chess engine 8. The chess engines 1-7 are also weakened versions of Stockfish 13. Play Magnus also employs an array of 29 chess engines, ranging from easy to very difficult.

All chess engines incorporate an evaluation function that is used to evaluate a chess position after a move. If an evaluation function = +1.00, then White is said to be ahead by one pawn. If an evaluation function = - 2.50, then Black is said to be ahead by 2.5 pawns. Many evaluation functions provide values in terms of a unit being one pawn. Stockfish 14 uses NNUE (Efficiently Updatable Neural Networks) to evaluate chess moves. NNUE is an advancement in the evaluation of chess moves and positions and is now available on chess.com.

Chess.com is an example of a chess website that makes an evaluation function available to evaluate moves by chess players. The evaluation function used in chess.com can classify moves in various categories: (1) excellent move, (2) good move, (3) inaccuracy, and (4) blunder.

With chess engines readily available on the Internet and evaluation functions freely used to evaluate player chess moves, two lines of inquiry are evident. One line of inquiry is research on chess among chess engines (i.e., artificial chess players). Another line of inquiry is research on the incidence and nature of blunders by games between chess engines (i.e., artificial chess players), between human chess players, or between human chess players and chess engines.

Research on chess engines tend to be research on powerful chess engines such as Stockfish 14 and AlphaZero with their estimated Elo ratings in excess of 3200 (e.g., Silver, et al., 2018). Rare is research on chess engines with much lower Elo ratings that would be in the Elo rating range of many human chess players. Research on chess engines with lower Elo ratings may likely have more applicability to the study of chess among human chess players than the research on powerful chess engines. Bart, Ritter, and Ritter (2021) provided an example of research on chess engines with lower Elo ratings.

Bart, Ritter, & Ritter (2021) completed a study of chess engines in which they inquired whether the length of a chess game as measured by the number of moves in a game is related to the disparity in chess skill between the artificial chess players. One chess engine was chess.com Level 10 with an estimated Elo rating of 2300 (https://www.chess.com/forum/view/general/approximate-ratings-of-chess-com-computer-levels). That chess engine played 18 games against each of five chess engines with their estimated Elo ratings: (1) Play Magnus Age 10 – 1700 Elo rating; (2) Play Magnus Age 9 – 1500 Elo rating; (3) Play Magnus Age 8 – 1200 Elo rating; (4) Play Magnus Age 7 – 1000 Elo rating; and (5) Play Magnus Age 6 – 800 Elo rating (https://www.reddit.com/r/chess/comments/2qcv95/what_is_the_strength_of_the_play_magnus_app_at/). Those Elo rating estimates were estimates listed on the Internet by chess enthusiasts and were not validated through a series of games with opponents with validated Elo ratings.

A statistical analysis of the lengths of the 90 games between chess engines was performed. That analysis determined that game length was significantly inversely related to the difference in chess skill between chess engines. In other words, if the difference in chess skill between chess engines is large, then the game length will tend to be small and if the difference in chess skill between chess engines is small, then the game length will tend to be large.

Regarding research using evaluation function scores, Bart and Vergin are now engaged in a study using chess engines available on lichess.org. In games pitting a chess engine with a very high chess skill against various chess engines with lower chess skills, they are investigating whether chess engines with very low chess skill tend to commit blunders earlier in games than chess engines with higher chess skill.

The move analysis available on both lichess.org and chess.com makes use of NNUE, an advanced evaluation function associated with Stockfish that includes the identification of a best move. However, Stockfish does not provide a qualitative explanation of why the move identified as the best move is actually the best move, so that a human could understand why the move identified as the best move by Stockfish is the best move.

Bart and Vergin are attempting to interpret qualitatively the blunders (e.g., hanging a piece) being committed by the chess engines. Such blunder analysis done on games involving human chess players could be very useful in identifying the nature of blunders committed by human chess players at various skill levels. Such blunder analysis could provide guidance as to the instruction that is needed for human chess players who commit blunders at various sections of the game: opening, middle game, or endgame.

In summary, chess technology including chess engines has utility in teaching chess to university students and utility in investigating chess among chess engines and human chess players.

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