Does Chess Instruction Improve Algorithmic Computational Skills in Developmental Mathematics?

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Description of the Topic

An important skill needed in developmental mathematics is the ability to do algorithmic computations. Students are given formulas and are required to use the formulas to find solutions. Once students know the correct formula, they must apply the formula, then use steps taught in previous chapters to get the solutions. Students in developmental mathematics may know the formulas and the steps needed to get to the solution, but they do not know in which order the steps should be applied to get the solution. As students complete more practice problems, the problems appear to be changing. Some students do not realize that the same steps should be applied. Unfortunately, these students do not do enough practice problems to recognize that the problems they complete have similarities as opposed to thinking that different problems require different steps.

Chess players are also required to know steps needed to win a game in a certain time period. They are not given formulas, but they can see how certain games are won by observing or reading about how the great chess players(grandmasters) are able to win their games. Given certain chess positions on a chessboard and the type of chess pieces on the board, an algorithm is used to win the game (checkmate). An example would be if you have a queen, rook, and King, and your opponent only has a King. No matter what the position of these pieces, the steps used for you to get the checkmate will remain the same. The difficulty for chess players is the same for those students in developmental mathematics; in what order should the steps be done so that a solution is found?

Purpose of the Paper

The purpose of this paper is to determine if chess instruction will improve the abilities of developmental mathematics students to perform algorithmic computations. This poses the question of incorporating chess instruction into the community college curriculum. Teaching developmental mathematics students for several years, I have had a large number of students fail my course as a result of not understanding what steps to use when required to complete math problems. Because of the number of steps required, students in developmental mathematics strongly dislike the subject. On the contrary, chess players really like playing chess. As a result, chess players are likely to have more experience using algorithms to arrive at the desired solution (a checkmate or gain of material). The great chess players remember several positions. They often make moves that can bring the chess pieces to one of these “familiar” positions. In beginning algebra (a developmental math course), students try to do steps that make unrecognizable and complex equations into those that are “familiar”.

Rationale and References to Theory

If students have more experiences in using algorithms, they are likely to perform better in mathematics. Chess also improves patience and visual and spatial reasoning, which are other useful skills for developmental mathematics students. As a result of students missing these skills, the students are failing math courses at an alarming rate. This paper will primarily focus on the importance of algorithmic computations, but will also look into other relationships that chess has with mathematics. There is very little research done on this topic

of chess instruction and the use of mathematical algorithms. Obviously, it is a great advantage for both chess players and developmental mathematics students if students can understand the algorithms along with the order of steps involved with these algorithms. Since chess players use these algorithms so often, it is likely that chess players would have an edge intellectually in mathematics to those who do not play chess.

Definitions

An algorithm is a step-by-step problem solving procedure, especially an established recursive computational procedure for solving a problem in a finite number of steps. Developmental mathematics courses for this study will include Basic Mathematics, Pre-Algebra, Introductory Algebra, and Intermediate Algebra.

Audience

Community colleges would take an interest in this paper because of the poor performances of developmental mathematics students. Teaching chess at the community college level may improve performance in developmental mathematics. Since students that play chess actually like the game, there may be more motivation from developmental math students to work using algorithms in chess than in mathematics. This study can be used at any school from 8th grade and above that offers mathematics at any level since mathematics primarily uses algorithmic computations at these levels.

Literature Review

We may look at the developmental mathematics topic of graphing and make a comparison with a chessboard and the first quadrant of a coordinate plane. A chessboard is comprised of an 8 x 8 square containing 64 smaller squares. Therefore, we may consider a coordinate plane in the first quadrant considering 8 units on the x-axis and 8 units on the y-axis. Students may then locate pieces on the chessboard by considering each square of the chessboard as an ordered pair. The lower-left corner of the chessboard (a black square) would be given the ordered pair (1,1). The upper-right corner of the chessboard would be given the ordered pair (8,8). A developmental math student can be asked to find the ordered pairs of each piece to begin a chess game (or during the middle of a game). At the beginning of a chess game, the two white rooks have the ordered pairs (1,1) and (8,1), the two white knights have the ordered pairs (2,1) and (7,1), the two white bishops have the ordered pairs (3,1) and (6,1), the white queen has the ordered pair (4,1), the white king has the ordered pair (5,1), and the eight white pawns have the ordered pairs (2, m) where m goes from 1 through 8. Students can then find the ordered pairs of the black pieces using previous information about the locations of the white pieces.

The most complicated piece to understand in chess is the Knight. The Knight's tour on the chessboard can also be demonstrated using a mathematical

approach. If we just look at the movement of the Knight only, we can compare its movement to the slope. The slopes (which we will consider as y/x or rise/run) related to knight's tour are 1/2,
-1/2, 2/1, and -2/1. For example, if a Knight begins at the location (4,4), there are eight new locations for the Knight's next move. These new ordered pairs are (3,6), (5,6), (6,5), (6,3), (5,2), (3,2), (2,3), and (2,5). Keep in mind that the four slopes can be rewritten as
-1/-2, 1/-2, -2/-1, and 2/-1, respectively. In a chess game, one must be able to plan as to where the Knight (or any other piece) can be relocated on its next move. This is similar to mathematics in that the slopes for equations of lines are used to locate points for the future. Looking at mathematics word problems (a great struggle for developmental math students), students must understand that there will be constraints in word problems. If one considers an employee's gross pay as a function of the number of hours worked, say y = 10x, some ordered pairs of the graph of y = 10x would not be considered. These ordered pairs would be those that the x or y coordinate was negative. Movements of the knight as well as other chess pieces also have limitations in their movements depending on their location on the chessboard. For example, a knight located at (2,7) cannot move using the slopes 2/1, 2/-1, 1/-2, or –1/-2 since the knight would no longer be on the chessboard.

Not just is chess useful for developmental mathematics students in learning certain topics, but simply for learning mathematics in general. Playing chess emphasizes important skills such as critical thinking and collaborative

learning which are necessary to effectively make algorithmic computations. When developmental math students complete problems, they are generally very similar problems. These students need to use algorithms to get problems that originally look different into problems that look more familiar. In chess, players are given new problems with every move. Players have a better idea as to what moves to make if the position of the pieces is familiar to that player. In a math class, students are often given the opportunity to work together on problems and get feedback on their ideas. Players may also be given chess puzzles that challenge students to find the right solution to win a game. Chess was thought to actually accomplish tasks closely correlated with the NCTM Professional Standards for Teaching Mathematics (Schommer, 134).

Those people who are very analytical tend to have the most success in mathematics. This is also true for chess players. The best chess players (grandmasters) look very carefully at the details of the chessboard. A grandmaster cannot use an algorithm (sequence of moves) until the pieces are in their proper places. Similarly, a developmental math student cannot use the algorithm of the quadratic formula until the equation is algebraically manipulated to $ax^2 + bx + c = 0$. These students who are analytical may be described as “field independent individuals”. Schmeck(2) describes these people by stating that they have an interest in operations and procedures, or the “proper” ways of doing things and prefer step-by-step, sequential organizational schemes. They are not influenced by others and are not as easily frustrated. Field dependent individuals look at solutions from a global approach. They are not as interested in details.

They tend to primarily look at the big picture while being interested only in the solutions and not the details behind the solution. Research shows that Field Dependence is highest amongst minorities and females (Smith, 5). Ironically, African-Americans students tend to be placed in developmental math courses as opposed to being placed in credit math courses. It is very important for developmental mathematics students to be aware of the details in various problems or they will have trouble determining what algorithms should be used for a given problem. Because of the details of relating the movements of the pieces and where the pieces can relocate after each move (considering the chess rules) in a particular game, chess enhances intellectual abilities related to abstract thinking, problem solving, and an analysis of spatial relationships(Smith, 7).

Unfortunately, most developmental mathematics students are not analytical. Although beginning math students have been familiar with the mathematics that they were taught, many of them forget almost all of the mathematics that they have learned in high school. As a result, they are often taught as if they have no mathematics skills at all. Teaching chess to people who know nothing about chess follow similar methods as teaching beginning mathematics. The following tips are used in the article “Teaching Chess to Young Children”: (1) Start small. (2) Play minigames. (3) Model your own problem-solving skills and point out the advantages and disadvantages of your own moves. (4) Allow do-overs. (5) Listen to the children. It is natural for teachers to start with the simplest problems (those that involve few algorithmic steps). The

algorithms should become more complex only after students have mastered understanding of the small problems. Playing minigames in chess (using just a few familiar pieces) is similar to taking textbook problems (perhaps unfamiliar to students) and rewriting them into problems that students are more familiar with. Modeling problems that students can relate to real-life is very important in developmental mathematics. Several of these students don't realize why mathematics is used in the real world. Students can also learn why using common sense can eliminate answers students obtain through careless errors. Do-overs are used often in developmental mathematics because of the high probability of these errors. Students often are given several practice problems in order to continuously practice these algorithmic computations. Through listening, professors get a better idea as to why careless errors are being made as well as possible misunderstanding of given algorithms. In my classes, developmental math students are required to write journals to communicate to me how they feel about mathematics and feedback is given to the students as to what they can do to improve their mathematical abilities. Through playing chess, their (the children) problem-solving and logical thinking skills flourished (Bankauskas, 34).

Another very important component of both chess and mathematics is time pressure. Tournament chess games and mathematics tests have "a fixed limit which adds to the requirements of rigorous concentration and self-discipline"(Hall, 6). In tournament chess, players need to apply the common algorithms of chess quickly or the game may be lost regardless of the position of the pieces on the chessboard. In other words, if a player knows the algorithm

(sequence of moves necessary to obtain a positional or material advantage) and knows when to apply it, this becomes irrelevant if the player takes too long to apply the algorithm. If a player runs out of time, the player loses (unless the opposing player does not have the material necessary to win). Similarly, when a student is given a math test, it is timed and students are given a grade only based off of what they have shown on the test. If a student takes too long to use an algorithm, the student may not be given time to complete other problems on the test. The amount of time given in a chess game is critical in determining how the game is played. A game may last anywhere from 2 minutes up to 6 hours. Shorter games require that players have memorized many different types of algorithms and must be able to apply them very quickly. Longer games require that players take time to memorize and apply more complicated algorithms. When students have a small amount of time to complete exams, students have to be able to apply these algorithms quickly in order to make time to complete all problems. Unfortunately, students tend to rush and make careless mistakes if they are given less time to complete a test. If students are given a lot of time to complete tests, professors usually will require students to know more algorithms or more complicated algorithms. Students are given more opportunity to take time to go over their mistakes. Even when students are given more time, they still will need a plan as to how they will go about completing a test. Students are often told to do the easy problems first (those that may require few algorithmic computations) and then do the harder problems (those that may require more complex algorithmic calculations) last. Planning is also very important in chess.

Tournament chess players generally have a plan at the beginning of the game. This plan requires a player to have knowledge of a particular chess opening. As with mathematics, the plan requires careful studying. As students can analyze a test, players can analyze a chess game. Both use algorithms that students either used correctly or incorrectly. Students and players can get assistance as to the clarity of the algorithms used. These math tests and tournament games require "constant practice and study; memorizing; trying new ideas (more than one way to get an answer or solution) (Hall,5).

In reviewing the literature, one can see that chess can be very useful in enhancing the algorithmic computational skills needed in developmental mathematics. There have been only a few schools they have actually adopted the idea of using chess as a credit course in high school or community college. From my experience, students have difficulty in determining when to use certain algorithms. Chess would be an excellent game that can be used to improve these skills. Problem-solving is a major component in determining success in chess. Students in developmental mathematics have difficulty in these areas. Other areas of interest in chess are planning and critical-thinking. Planning in mathematics has many components ranging from completing a simple problem to planning how to prepare for a final exam. Chess players also plan by looking at a chess puzzle to determining what opening they may use in a national chess tournament. The major task in bringing chess into community colleges will be convincing the administration and students of these colleges that chess can definitely improve understanding in developmental mathematics courses as well

as showing that there are many similarities between the algorithms used in developmental mathematics and those algorithms used in chess.

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