CHESS – FOUNDATION FOR MATHEMATICS:

In what ways can Chess improve a child's mathematical skills?

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Abstract: This paper aims to find the positive correlation between chess and Mathematics and then mention them. It further discusses how these skills which are required for chess would also be of great importance in mathematics. Moreover,some chess problems which need to be solved using concepts of mathematics have been added to persuade children to try and come up with their own problems and solutions. Creative and critical thinking are two other important skills that chess supports. Through the medium of the examples, the paper tries to demonstrate how those skills are correlated to chess. Towards the end, the paper persuades the introduction of chess in schools backed up with previous efforts that have been made to promote chess in schools. Chess is a game that needs the use of one's mental aptitude as well as strategic thinking skills. These abilities are useful in various areas of life, notably mathematics. It aids in the development of various skills - it strengthens basic calculations , improves memorization ability, improves concentration power , develops foresight, and instills time management.

Keywords: Critical Thinking,mental aptitude, supplement, time management, concentration power, foresight.

Subject: Chess, Mathematics

Introduction

As a kid, some of us might have played chess in our school curriculum or with our friends as a means of fun. But this game is also known to have a lot of benefits. It's a great way to relax your mind from the ongoing daily routine and also improve your mind's thinking capabilities.

The European Parliament (2012) declared "…whatever the age of the child, chess can improve children's concentration, patience and persistence and can develop the sense of creativity, intuition, memory, and analytic and decision-making skills; whereas chess also teaches determination, motivation and sportsmanship."

Studies in both Canada and the United States found elementary school students had significant increases in memory and verbal reasoning skills and increased gains in mathematical problem solving.

Methodology

This paper uses a secondary, qualitative method of research. This is because the content is somewhat influenced by other papers' findings and the fact that this paper is not based on any comparison or numerical data.

The limitations of this method are that it can be subject to the researcher's bias, i.e., the author can portray things in a manner that suits their opinion, as there may be no definite data supporting his claim.

Results & Discussion

Numerous researchers have argued that chess can help improve students' educational performance (Smith & Cage, 2000; Scholz et al.,2008; Kazemi et al., 2012; Trinchero ,2013; Jerrim et al., 2016;). Sala & Gobet (2017) stated that chess "combines numerical, spatial, temporal, and combinatorial aspects … and helps foster attention, problem solving, and self-monitoring of thinking (i.e., metacognition)".However, Gobet & Campitelli (2006) argued that "the educational effects of chess training remain undetermined" and that "compulsory chess instruction may engender motivational problems among students. "

Chess and its influence on maths:

Firstly, each piece holds a specific value. For example, the queen is worth 9 points, but a bishop is worth just 3 points. Thus, it would be counterproductive to swap a queen for a bishop because the player would lose 6 points. This can help young children improve their fundamental subtraction abilities.

Secondly, openings are a must for chess players. They are a set of fixed moves that both sides play in the beginning, and when executed perfectly, they may lead to a successful middle game. The same scenario exists in mathematics, where a person must master formulas to answer problems. Chess can therefore help to strengthen one's memory (Ortiz et al., 2019). Even within openings, there exist variations. So, a chess player is required to understand - and often memorize - numerous variations in order to be able to play against them.

Thirdly, chess requires the utmost use of the mind in order to foresee any threat posed by the opponent; one wrong move may cost the player the whole game. The same goes true for math; one wrong step or calculation can prove your whole answer wrong. Thus, it inculcates a very important skill - *concentration*(Gobet & Campitelli,2006)

Furthermore, it develops a sense of *farsightedness* (Tanajan et al., 2012). One needs to think many moves ahead to make sure they aren't making a mistake while moving. Parallelly, in mathematics, we are required to solve several steps in our heads.

Moreover, *critical thinking* is another crucial skill set that chess promotes (Feruson, 2012; Ortiz et al., 2019). There are several sorts of puzzles in chess, such as mate in one, two, three, or more moves. All of these require the person to thoroughly analyze the situation before acting. One will also have to thoroughly understand a word problem in mathematics in order to solve it.

Additionally, most chess games are time bound i.e., one will have to think and act fast so that they can avoid losing time. The opening should be played out quickly to save time for the middle and end games. In

modes like rapid and blitz, one is sometimes required to move within a fraction of seconds. Similarly, in mathematics, one needs to solve questions in a particular time frame; they cannot allocate too much time to one question, otherwise they risk missing out on completing the others. Thus, it teaches us the value of *time management*.

This paper now explores some mathematical problems involving the chess board. There are several questions that may be constructed, and students can create their own questions and then answer them. Thus , chess also fosters *creativity*(Ortiz et al., 2019). For example, how many combinations are possible for the starting move of both black and white?

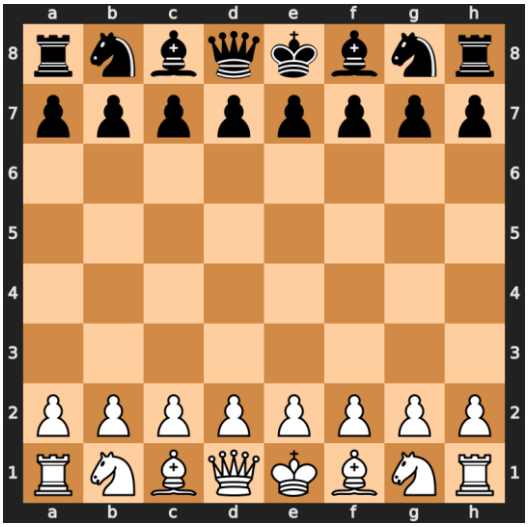

Figure 1: A standard chess board

White can move one pawn in two different ways. Hence, a player can move 8 pawns in 16 ways. For example, the pawn at e2 can be moved in two ways, e4 and e3, and the pawn at d2 can be moved in two other ways, d3 and d4.

Likewise, one knight can be moved in two different ways, and two knights can be moved in four ways. The knight at b1 can be moved to c3 and a3; the knight at g1 can be moved to f3 and h3. However, no other piece except for the knight and the pawn can be used as a first move as they are blocked by the pawns. Hence, white has 20 combinations with them, and they can choose their starting move in $20C_1$ ways (C_1 here is the choice from 20 options).

In the same way, black can select their starting move in $20C_1$ ways.

Therefore, total number of starting positions = $20C_1 \times 20C_1 = 20 \times 20 = 400$

Another problem could be how many rectangles are there which are not squares?

If you have a look at the chessboard, you can see that there's a total of 9 lines each horizontally and vertically. Out of these lines, a rectangle can be formed by selecting any two lines both horizontally and vertically. So, number of rectangles = $9C_2 \times 9C_2 = [9 \times 8/2]^2 = 1296$. But, these are the number of rectangles including the squares. As a result, we'll have to subtract the number of squares.

Number of 1×1 squares = 8^2

Number of 2×2 squares = 7^2

……..

Number of 8×8 squares = 1^2

Hence, the number of squares = $8^2 + 7^2 + 6^2 + 5^2 + 4^2 + 3^2 + 2^2 + 1^2$ = 64 + 49 + 36 + 25 + 16 + 9 + 4 + 1= 204

OR

$\sum 8^2 = 8 \times (8+1) \times (16+1) /6 = 204$

$[\sum n^2 = n(n+1)(2n+1) / 6]$

Therefore, the number of rectangles which are not squares are 1296 – 204 = 1092. Just in this way, one can form his own questions and hone his mathematical skills.

-The Knight's Tour

Leonhard Euler, a famous mathematician and physicist, created a semi magic square which was also another solution for the infamous Knight's Tour Problem. A magic square is one in which the sum of all the numbers in each row, column and diagonal is the same. The Knight's Tour is a sequence of moves of a knight which enables it to traverse the entire board.

1	48	31	50	33	16	63	18
30	51	46	3	62	19	14	35
47	2	49	32	15	34	17	64
52	29	4	45	20	61	36	13
5	44	25	56	9	40	21	60
28	53	8	41	24	57	12	37
43	6	55	26	39	10	59	22
54	27	42	7	58	23	38	11

Figure 2 : A chess board depicting the squares taken by the

knight to traverse the entire board

The knight was placed on the position labeled as 1 and was moved through the entire board till the 64th square. The sum of each row and column add up to 260. For instance the summation of the numbers in the first row=1+48+31+50+33+16+63+18=260.The summation of all the numbers in the first column= 1+30+47+52+5+28+43+54=260

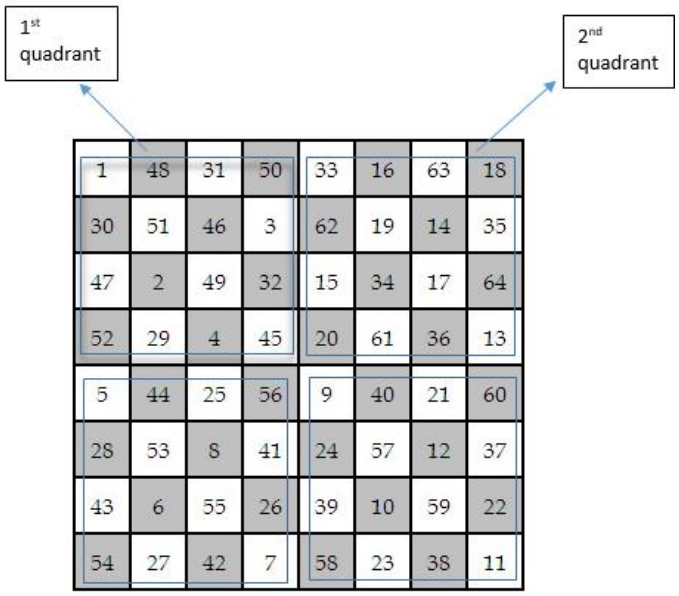

Figure 3:A chess board depicting quadrants

Surprisingly, the sum of all the numbers of each quadrant is also the same i.e. 520.

Moreover, sum of each half row and half column adds up to 130.

The sum of the first half row = 1+48+31+50 or 33+16+63+18 = 130

The sum of the first half column = 1+30+47+52 or 54+43+28+5 = 130.

Unfortunately, the sum of each of the diagonals does not add up to 260.

Sum of numbers of the first diagonal = 1+51+49+45+9+57+59+11= 282

Sum of numbers of the second diagonal = 18+14+34+20+56+8+6+54=210

Thus, the chess board is a place where one can combine his thinking skills along with his mathematical knowledge to come up with possible solutions for a problem. All these problems are a testament to the above statement.

Introduction of Chess in schools :

As mentioned in the beginning of the paper, the European Parliament had enlisted the various benefits of playing chess which were not only restricted to mathematics but many other fields as well. A Chess in Schools program was endorsed by the European Parliament to promote the introduction of chess in schools. The NYCHESS program sends an experienced chess instructor to the schools to establish a chess program. The NYCHESS instructors teach five lessons and help a teacher in the building develop an ongoing program. The instructors are assisted by high school chess players and students from the local school who excel in chess. The youths serve as assistants and work with the pupils between visits from the NYCHESS instructor (Palm, 1990, pp. 4-5). Another program named ‘Chess in Schools and Communities’ aims to introduce chess to schools and inner city communities and has partnered up with more than 300 schools across the UK. Similarly, many other programs are being initiated with the motive of introducing chess to children. Hence, teaching chess to students from a young age itself would be of great benefit to both the

school and the students as it would reward the school with brilliant minded kids and enhance or develop various skills for the child.

Conclusion

Chess has a significant impact on many life skills, which also form the foundation for Mathematics, and it is strongly suggested to play this game as it will assist in giving a boost to the minds of young people.It is recommended that chess be adopted by schools as a part of their curriculum. This would help students strengthen their foundation and inculcate qualities like time management, critical thinking, farsightedness, and concentration. Combining chess with other mentally stimulating games like Sudoku can exponentially compound the results of such activities.The intent of the example problems above is not to teach them how to solve that problem, but rather demonstrate the vast number of problems one could come up with and then attempt to solve them. It is to motivate them not to limit their knowledge, and hence instill a sense of creativity. One might find a solution to an unknown problem. Future studies can be conducted that utilize a primary method of research to cross-compare the findings and drive research in this field.

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