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ABSTRACT

This paper describes in detail the paper-and-pencil POE (Pelham Odd 'R Even) game, in which units of space are the allocated resources. The game is designed to provide an introduction to the rule structure common to the games of EQUATIONS, WFF 'N PROOF, and ON-SENTS & NON-SENTS. Techniques of playing POE, including goals, solutions, moves, scoring and variations of the game, are included. (JBW)

Abstract

RESOURCE ALLOCATION GAMES: A PRIMING GAME FOR A SERIES OF INSTRUCTIONAL GAMES (The POE Game)

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The Poe (Pelham Odd 'R Even) Game, which can be played with paper and pencil, is designed to provide an introduction to the rule structure common to the following games: EQUATIONS (mathematics); ON-WORDS (word structure); ON-SETS (set theory); WFF 'N PROOF (symbolic logic); and ON-SENTS & NON-SENTS (language structure, in preparation). The resources allocated in the POE Game are simply units of space. The resources allocated in each of the other games are symbols which represent the fundamental ideas of the subject matters of the respective games. Thus, in playing EQUATIONS, for example, the player is actually doing mathematics. The POE Game is exhaustively described: it is simple but rich in potentialities for leading to the other games which deal with the fundamental intellectual skills of language, logic, and mathematics. The author recommends that these games be embedded in a classroom teams and tournament structure which facilitates cooperation among students of disparate abilities and competition among students of relatively equal abilities.

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RESOURCE ALLOCATION GAMES:

A PRIMING GAME FOR A SERIES OF INSTRUCTIONAL GAMES

The POE Game

(Pelham Odd 'R Even Game)

by

Layman E. Allen

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RESOURCE ALLOCATION GAMES: A PRIMING GAME FOR A SERIES OF INSTRUCTIONAL GAMES (The POE Game)

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The significance of the Pelham Odd 'R Even game (we call it the POE game for short) is not the subject matter presented in the game, but the variety of subject matters opened up to students when they learn the POE game and others similar to it.

Before saying more about the fields of knowledge dealt with in such games, it should be acknowledged that the word 'Pelham' in the full name of the POE game refers to the Pelham Middle School in Detroit, Michigan, the school in the center of that city where this game was tested, refined, and developed. Pelham is an extraordinary school with really extraordinary leadership starting with its principal, Lewis Jeffries. The chairman of the mathematics department there, Gloria Jackson, and another exceptional mathematics teacher, William Beeman, made especially significant contributions to the development of the POE game, and many other members of the staff have been and continue to be involved in presenting it widely throughout the school.

The POE game deals with allocating resources, and the resources allocated are units of space. Playing the POE game opens the door to an approach to learning that may significantly alter participants' ideas about learning and thinking. Because the POE game is defined by rules that are very similar in structure to rules for other games that teach specific subject matter, after a player has mastered the POE game he or she will be ready to begin learning

... mathematics by playing the game called EQUATIONS,

... word structure by playing the game called ON-WORDS,

... set theory by playing the game called ON-SETS,

... symbolic logic by playing the game called WFF 'N PROOF, and

... language structure by playing the game called ON-SENTS. & NONSENTS.

These five games are like the POE game in that the basic pattern of play is to allocate resources. The resources in these games are symbols, imprinted on cubes or paper, that represent fundamental ideas in the subject field dealt with in the play of each of the games. When the rules defining such games are appropriately structured, the resulting activity can be a powerful instructional interaction. It is possible to organize around such games a learning environment that emphasizes interaction of peers and individualization of educational experiences. Students who vary widely in their skill and understanding of a given subject work together creating problems for each other and solving them by the way that they play the games so that each student has a highly individualized learning experience, appropriate for him at his current level of understanding of the subject. In the learning of mathematics, we call this kind of learning environment a HELM (Heuristic Environment for Learning Mathematics). The effectiveness of such a learning environment has recently been shown in a series of studies by a team at Johns Hopkins.[1] The studies show that a classroom structured as a HELM through the use of games and teams significantly increases achievement in the learning of mathematics, significantly increases interaction among students of different races and different sexes, and results in feelings by students that such classes are significantly more satisfying, less competitive, and less difficult than traditional classes. It is my contention that in such settings, ideas tend to be voraciously pursued. Students have something to do with the ideas that they are engaged in mastering; they don't merely hear them or see them expressed in print.

With these preliminary remarks, which have given some reasons why you should learn the POE game, which have hopefully motivated you to want to learn to play POE, let us turn to the serious matter at hand of learning to play the Pelham Odd 'R Even game. You will need to look elsewhere to learn the similar games that teach such diverse subject matters as mathematics, word structure, set theory, symbolic logic, and language structure.[2]

Permitted Connections

The beginning POE game is played on a 3x3 matrix which is called a network. All the equipment needed to play is a pencil and paper. Two or more persons can play; three-player games are best. After the goal is set, the players take turns writing F's, P's, or R's in the vacant squares until some player challenges or declares a force-out. In deciding whether to challenge, to declare force-out, or to write and what to write, whenever it is your turn, you will need to analyze the number of connections in the network at that time. The following is an example of a connection:

GOAL

Top

Left

1 P	2	3
4 P	5	6
7 P	8	9

Right

Bottom

The set of three squares, 1, 4, and 7, is a top-bottom permitted connection. This set of squares is a connection because any set of three appropriately-filled touching squares that runs either from the top to the bottom of the network or from the left side to the right side of the network is a connection; and having P's in them, these squares are appropriately filled. It is a top-bottom connection because it runs from the top of the network to the bottom. It is a permitted connection because it has 0 R-squares, and any connection that has 0, ~~2,~~ or 3 R-squares is a permitted connection.

Required Connections

If R's are added to the network in squares 5 and 6, then a required connection and three additional permitted connections are added to the network.

GOAL

1 P	2	3
4 P	5 R	6 R
7 P	8	9

The three permitted connections added are the left-right connections, 156, 456, and 756. Why are they permitted connections? (Each has 2 R's.) Why are they left-right connections? (They go from the left side to the right side of the network.) The required connection added is 157. It is a required connection because any connection with exactly 1 R-square is a required connection.

F-squares

If an F is added to the network in square 3, are any connections added to the network? The answer is no, because neither permitted connections nor required connections have an F-square in them, and every connection is either a permitted one or a required one.

GOAL

1 P	2	3 F
4 P	5 R	6 R
7 P	8	9

Counted Connections

In determining the number of connections in a network, some connections must be counted while others may or may not be. The relationships between F-squares, R-squares, permitted connections, required connections, and being counted is summarized in Figure 1.

The POE Game

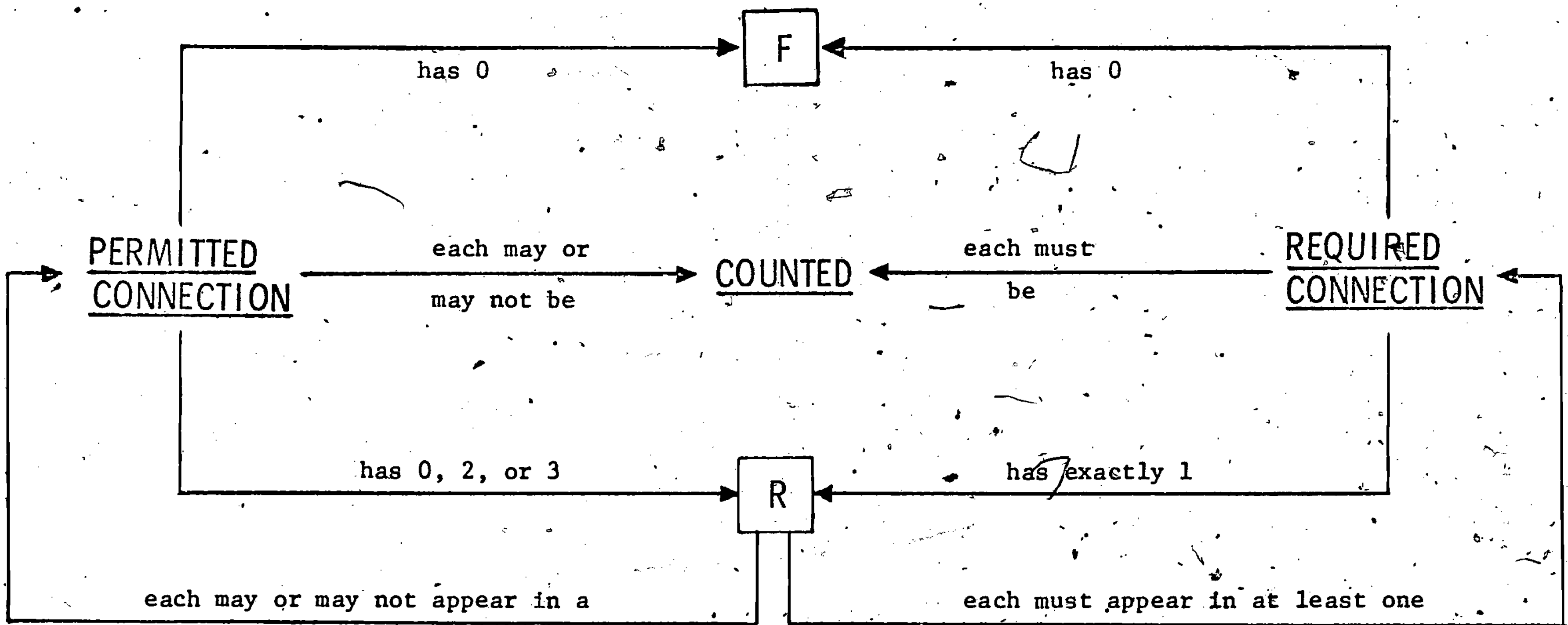


Figure 1

Each permitted connection has 0, 2, or 3 R-squares, 0 F-squares, and may or may not be counted, while each required connection has exactly 1 R-square, 0 F-squares, and must be counted. Hence, each connection consists entirely of R-squares and P-squares.

An important relationship between R-squares and required connections, indicated in Figure 1, has not been mentioned yet. For some set of counted connections of a network to be a solution to the goal that has been set, each R-square in the network must appear in at least one required connection. On the other hand, R-squares may either appear or not appear in permitted connections that are counted; this is up to the solution builder, since he may choose which permitted connections (if any) to count.

Goals and Solutions

The first player sets a goal in the beginning POE game by writing an O or an E on the GOAL line above the network. If he writes an O as the goal, any odd number of counted connections in the network that satisfies the rules of Figure 1 will be a solution; if he writes an E, any even number (except 0) of counted connections in the network that satisfies the rules of Figure 1 will be a solution.

If the goal set in the network we have been considering had been an E, would there be any solutions to the goal after the F was written in square 3.

E
GOAL

1 P	2	3 F
4 P	5 R	6 R
7 P	8	9

The answer is no, because R-square 6 does not appear in a required connection in any set of connections.

Suppose that after the F is written in square 3, a P is written in square 8. Are there any solutions then?

E
GOAL

1 P	2	3 F
4 P	5 R	6 R
7 P	8 P	9

Yes, there are many solutions in this network, 16 to be exact. With the P added to square 8, there are five permitted connections (147, 148, 156, 456, and 756) and four required connections in the network (157, 158, 486, and 786). Any even-numbered set of these nine connections that contains all four of the required connections is a solution. Hence, there is just one 4-connection solution, namely:

S1 157 158 486 786

There are ten 6-connection solutions. Examples:

S2 157 158 486 786 147 148

S3 157 158 486 786 147 156

There are five 8-connection solutions. Examples:

S12 157 158 486 786 147 148 156 456

S13 157 158 486 786 147 148 156 756

To bring out another feature of the number of connections in a network it is worthwhile to consider another example. Suppose that, instead of a P in square 8, a P is written in square 9. Are there any solutions then? How many connections are there?

E
GOAL

1 P	2	3 F
4 P	5 R	6 R
7 P	8	9 P

No, there are not any solutions because R-square 6 still does not appear in any required connection in any set of connections. The tricky part of this network is that it contains five required connections: 157, 159 left-right, 159 top-bottom, 459 and 759. The set of squares, 159, is a double connection, each of which contains only one R and is thus required. There are also four permitted connections (147, 156, 456, and 756); making a total of nine connections in all.

P-flubs

In the following example, after the E-goal has been set the players have taken turns writing F's in squares 2, 5, and 8. Then Player 2 writes an F in square 6. Hereafter the most recent move will be encircled as shown here. After the F is written in square 6, is it still possible to get a solution to an E-goal in this network?

E
GOAL

1	2 F	3
4	5 F	6 (F)
7	8 F	9

The answer is no, because after that move it is impossible to get to an even number of connections. By his move Player 2 has made what is called a P-flub. He has prevented anyone's ever getting to a solution, no matter how the remaining squares are filled in. When anyone writes a letter in the network, he is claiming that it is possible to still get to a solution. But in this case, Player 2's claim is false, and false claims are flubs which can be immediately challenged by any other player. That's one way to win in the POE game -- to correctly challenge a player who flubs. So you need to watch very carefully what other players write in the network, and challenge them if they flub.

Consider another example. The goal set is odd, the first three moves placed an R in square 1 and F's in squares 2 and 4, and the most recent move is an F in square 5.

O
GOAL

1 R	2 F	3
4 F	5 (F)	6
7	8	9

Is this move a flub? (Yes.)

What kind of flub? (A P-flub.)

Why is it a flub? (Because it is impossible to use the R-square 1 in a required connection. No solution is possible unless that is done, and it cannot be done.)

Notice that anybody except the mover can challenge. The mover is the player who has just written a letter in the network. Although players take turns moving, you do not have to wait until it is your turn in order to challenge. You can make a challenge at any time other than when you have just moved. A challenge is always directed to the most recent mover. It is a declaration that he has flubbed.

Burden of Proof

Once a challenge is made, somebody is going to have the burden of proving that it is possible to get to a solution. In general, the burden of proving that it is possible to get to a solution will be upon the player who is claiming that it is possible to do so. In this situation, where the challenger has declared that the mover made a P-flub, who is claiming that it is still possible to get to a solution -- the challenger or the mover? The mover is the one who is claiming it, so he is the one who has the burden of proof.

Will the mover be able to show that it is still possible to get to a solution? No, he will not; so the challenger will win and the mover will lose.

To sustain his burden of proof a player must write out as many 3-digit numbers as necessary to indicate the connections of the network that he is counting in the set that he is offering as a solution.

Joining

In a three-player game once there is a challenge and the challenger says what kind of flub the mover has made, the third player must join with either the mover or the challenger -- whichever one he thinks is right. Consider the following example. After the odd goal has been set and F's have been written in squares 3, 5, 7, and 8, Player 3 writes an F in square 6.

O

GOAL

1	2	3 F
4	5 F	6 (F)
7 F	8 F	9

Is this move a flub? (Yes.)

What kind of flub? (A P-flub.)

Why is it a flub? (It is impossible to get an odd number of connections after this move; it is impossible to get any connections.)

Who has the burden of proof? (The mover.)

Will he be able to sustain his burden of proof by showing that it is still possible to get to a solution with an odd number of connections? (No.)

If the third player -- we call him the joiner -- joins with the player who has the burden of proof, then the joiner also has the burden of proof. Otherwise, he does not. Suppose in this situation the joiner joins with the mover. Will the joiner have the burden of proof? (Yes.)

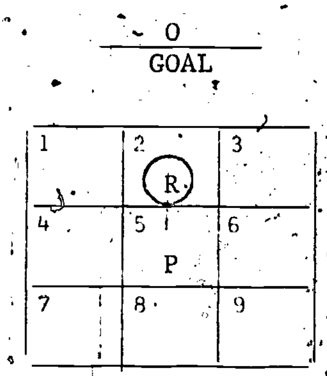
Whom should the joiner join? (The challenger.)

Why? (If he joins the mover, the joiner will have the burden of proof, and he will be unable to sustain it.)

So, in this situation, if the joiner joins the mover, they both lose and the challenger wins; if the joiner joins the challenger, they both win and the mover loses.

A-flubs

The kind of flub that the challenger says that the mover has made will determine who has the burden of proof and what he must prove. We have seen that for P-flubs the burden is cast on the mover. In the second of the three kinds of flubs -- namely, A-flubs -- the burden of proof is cast upon the challenger. The following example indicates why the challenger has the burden of proof for A-flubs and what he must prove. Suppose that after the goal of O is set and a P is written in square 5, Player 3 writes an R in square 2. What do you notice about this situation?



What should be noticed is that you can get to a solution with one more move. You can get to one connection -- an odd number -- that satisfies all the rules of Figure 1 by writing a P in square 7, square 8, or square 9.

Could the player who wrote the R in square 2 have avoided all such situations in which you could get to a solution in one more move? Did he have a move that would not have allowed such a solution? (Yes, he had many such moves. He could have written an F in square 1, or square 2, or square 3, for example.)

If by his move a player allows a solution in one more move when he could have avoided doing so without making a P-flub, we say that he has made an A-flub. He has unnecessarily allowed a solution by his move.

When the kind of flub declared is an A-flub, it is the challenger who is claiming that a solution can be built with one more move, so it is the challenger who has the burden of proof. He is also claiming that the mover was not forced into allowing such a solution; in other words, that the mover could have made a different move that would not have allowed such a solution and that would not have been a P-flub. Hence the challenger has two parts to his burden of proof on an A-flub challenge: (1) he must show that there is a solution with one more move, and (2) he must show that the mover had an alternative move that would not have allowed such a solution and would not have been a P-flub.

Consider another example. After the goal of E is set and an R written in square 5, a P is written in square 9.

$$\frac{E}{\text{GOAL}}$$

1	2	3
4	5 R	6
7	8	9 (P)

Is this move a flub? (Yes.)

What kind of flub? (An A-flub.)

Why is this an A-flub? (It is an A-flub because you can get to a solution with one more move -- a P in square 1.)

Is that alone enough to make the move an A-flub? (No.)

What else must also be so for the move to be an A-flub? (The mover must have had an alternative move that would not have allowed a solution with one more move and would not have been a P-flub.)

Who has the burden of proof on this A-flub challenge? (The challenger.)

If you were the third player, whom would you join? (You should join the challenger so that you, too, would have the burden of proof.)

Can you sustain your burden of proof? Consider the first part of it; is there a solution with one more move? (Yes, by writing a P in square 1, you can get to the solution consisting of the pair of connections 159 and 159.) So to sustain the first part of your burden of proof, you could simply write: P1, 159, 159.)

Now consider the second part. Could the player who wrote the P in square 9 have made another move that would not have allowed a solution with one more move and would not have been a P-flub? (Yes, he could, for example, have written an F in square 9. So to sustain both parts of your burden of proof you could simply write: P1, 159, 159, F9.)

C-flubs

The third and final kind of flub is the C-flub. This kind of flub occurs whenever a mover writes a letter in a vacant square and in doing so fails to challenge when he could have done so correctly because the previous mover had flubbed. Thus a C-flub will always stem from a previous flub. If it stems from a prior A-flub, it is called a CA-flub; if it stems from a prior P-flub, it is called a CP-flub. The burden of proof for CA-flubs is on the challenger; for CP-flubs, on the mover. The following is an example of a CA-flub. After the goal of 0 is set and an R is written in square 4 and a P in square 5, Player 1 writes an R in square 3.

0
GOAL

1	2	3 (R)
4 R	5 P	6
7	8	9

Player 1 has made a CA-flub because he could have challenged the previous mover for making an A-flub and sustained the burden of proof. After the prior move, a P in square 3 would have allowed the solution consisting of the single required connection, 453. The prior mover could have avoided this by writing an F in square 1.

The following is an example of a CP-flub. After the goal of E is set and R's have been written in squares 1, 2, and 5 and an F in square 4, Player 3 writes a P in square 9. His move is a CP-flub.

E
GOAL

1 R	2 R	3
4 F	5 R	6
7	8	9 (P)

The reason that writing the P in square 9 is a CP-flub is that the prior move was a P-flub. The prior move made getting to a solution impossible because after that move the R-square 1 cannot appear in a required connection. Player 3 should have challenged the P-flub instead of writing a P in square 9. The prior mover would have been unable to sustain his burden of proof.

Force-Outs

If a player does not wish to challenge or to write a number, his third option is to declare a force-out. Declaring a force-out has the effect of casting the burden of proof upon every player to show independently that there is a solution with one more letter written into the network. The player who declares a force-out should be certain that he can write a solution by writing in one more letter, because he will suffer in the scoring if he cannot. The following situation is one that should lead to a force-out.

O
GOAL

1 R	2	3
4 F	5 F	6 F
7 F	8 F	9 F

After the O goal has been set, an R written in square 1, and F's written in squares 4, 5, 6, 7, 8, and 9, it is Player 3's turn. He should write a P in square 2 or in square 3. If he writes anything else, he will make a P-flub. If he challenges, depending upon the kind of challenge made, either (a) he will have the burden of proof and be unable to sustain it or (b) the prior mover will have the burden of proof and it will be sustainable. If he declares a force-out, he will be unable to sustain the burden of proof. So, to avoid these consequences, he should write a P. Suppose he writes it in square 2. Then, the next player (Player 1) should declare a force-out. Each of the players will then have the burden of proof, and they will each be able to sustain it by writing: P3, 123.

Scoring

A player scores 2 points if he is a challenger, a mover, or a joiner to the mover and

a) he has the burden of proof and sustains it, or

b) he does not have the burden of proof and none of those who have it sustain it.

A player scores 1 point if

a) he is a joiner to the challenger and

1) he has the burden of proof and sustains it, or

2) he does not have the burden of proof and none of those who have it sustain it, or

b) a force-out has been declared and he sustains his burden of proof.

A player scores 0 points if he has not declared force-out and

a) he has the burden of proof and fails to sustain it, or

b) he does not have the burden of proof and some player who has it sustains it.

A player scores -1 points if he declares a force-out and is unable to sustain his burden of proof.

The winning player is either the high scorer (when play is for a specified period of time) or the first to reach the winning score (when play is to a specified winning score).

Tough POE

After the players have mastered the beginning POE game in which only goals of O or E are set, they can move on to an advanced version called Tough POE. In this version additional goals may be set.

One option is to set a goal consisting of a capital letter A followed by a number. For example, the goal of A6 will designate a goal which means "at least 6", and any set of at least 6 connections that includes all of the required connections of the network will be a solution to A6.

A second option is to set a goal consisting of a capital letter E followed by a number. For example, the goal of E8 will designate a goal which means "exactly 8", and any set of exactly 8 connections that includes all of the required connections of the network will be a solution to E8.

In the following situation after the goal of E5 has been set, R's have been written in squares 1 and 3, F's in squares 4 and 8, and a P in square 7, the writing of a P in square 9 is a P-flub.

E5

1 R	2	3 R
4 F	5	6
7 P	8 F	9 (P)

Do you see why?

Big Tough POE

For those who want to make the game even more challenging, there is a still more advanced version called Big Tough POE. It is played on a 4x4 network with the appropriate change in definition of a connection as a set of four touching squares appropriately filled which connect the top to the bottom or the right side to the left side. Long before players get this far along into the complex versions of the POE game, they should also have started into the subject matter games that are similar to the POE game -- the game of ON-WORDS (to learn word structure), EQUATIONS (to learn mathematics), ON-SETS (to learn set theory), WFF 'N PROOF (to learn symbolic logic), and ON-SENTS & NONSENTS (to learn language structure).

Conclusion

In conclusion, let me recommend that those educators who believe that the uses of language, logic, and mathematics are fundamental intellectual skills, and who are interested in creating heuristic learning environments in which students discover a great deal for themselves, consider introducing the POE game into the culture of their classrooms. It is a simple game but extremely rich in potentialities for leading to the development of such fundamental intellectual skills.

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