Review: Poly Plug Game Pack

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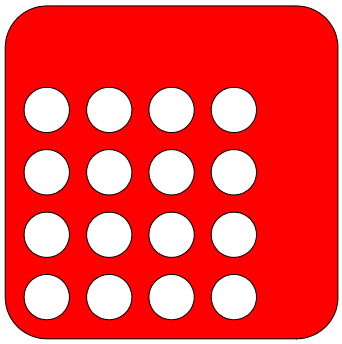
Poly Plug Game Pack first published in 1995 by Black Douglas Professional Education Services, ISBN 0 646 26589 X and currently available from Mathematics Centre.

This is Doug Williams' latest curriculum development. Simple sturdy equipment for playing games and other maths activities, with teacher materials, reprographable student materials and clear instructions. The pack contains:

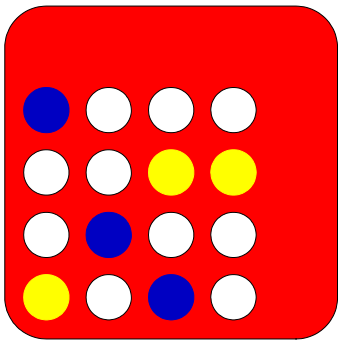
- two colored strong plastic-foam boards (one red, and one two-sided, blue on one side, and yellow on the other), each pre-cut with 25 round plugs (you might think of a Connect Four board with tight fitting counters in each hole), and
- a 51-page Resource book containing clear instructions, and more than 32 pages of blackline masters (game instructions and worksheets for exploring "What if ...?" and "Thinking it Through", and a template for making your own game).

The red and blue boards have the same square shape (let's not quibble over sensibly rounded corners—oh, alright, "squareish"). But the red board is only one-layer thick, whereas the blue-yellow board is two layers thick. Each of the cylindrical plugs cut from this bi-chromatic board is itself blue at one end and yellow at the other (think of a Reversi or Othello chip, black one side, white the other), and is twice as thick as a red plug. If a red plug is removed from the red board and a blue-yellow plug placed in the resulting hole, one layer of the two-color plug stands up above the surface of the red board - all the better to take plugs in and out, my dear.



What's the point? Well, by removing some of the red plugs, a pattern of holes can be made for playing mathematical games, using the blue-yellow plugs as counters or playing pieces. For example, suppose we leave the top and right-hand outer edges of the 5 x 5 red board filled with their red plugs, but we remove the rest of the red plugs. The result is a board rather like this.

Such a board can be used to play a game of 4 x 4 noughts and crosses, aiming to get either 3 in a row (the easy version of this Noughts and Crosses adaptation), or to get 4 in a row (the harder version), in the usual way. Here is an example of a game partly played:



- If it is Blue's turn, where should Blue go next?
- What if it is Yellow's turn?
- Who will win the 3-in-a-row version of the game?
- Who will win the 4-in-a-row version?

Then we can go beyond simple tactical questions such as, "What is player B's best next move?" to consider possible winning strategies, or blocking strategies for whichever player moves first, or second.

Incidentally, keep in mind that what may seem hard to think about, at first glance, in black-and-white text, is actually much easier when the concrete materials are present, and when players have had some preliminary experience with simpler activities. This is Piaget's and Bruner's fundamental point about so called "concrete" operations and manipulatives. Of course we can play this with pencil and paper. But using actual counters is easier. How often do we hear learners who make a move, and, as soon as they have placed the counter, say, "Oops! No, can I have that back?

That's *not* the move I want - I can *see* that now that I've moved". The undo-ability of counters makes working with counters much easier for beginning learners than the equivalent work using pencil and paper. As an alternative way of playing, if we allow each player only 6 counters, but once all 12 counters have been placed, a player may move any of his or her counters to any adjacent empty space – that's a different version of the 4 x 4 game, with moveable counters. Obviously this kind of game using movable counters can't be played with pencil and paper.

Now in fact this 4 x 4 version of Noughts and Crosses is *not* one of Doug Williams' games, although his first four games, starting with standard O & Xs, belong to the O & Xs family. I have suggested the 4 x 4 version as an obvious way of adapting Doug Williams' materials to go further still, and also as an easy way to indicate how the **Poly Plug Game Pack** works.

We could go further, and allow a kind of capturing game (think of Nine Men's Morris) where another player's piece may be captured if one player, for example, makes three in a row, or a square of four adjacent counters of one color. Or capture might occur if one player places three (or two) of his or her pieces next to one of the other player's pieces. Or a different capture might happen if one player places two of his or her pieces on either side of one of the other player's pieces. Perhaps think of Reversi capture, and change the color of the captured piece by turning it over, or simply take it off the board. We might allow a captured piece that is removed from the board to be used, in turn, by the capturer: think of Shogi, the Japanese chess-like game with useable capture.

We might go further, leaving Noughts and Crosses altogether, but still using a 4 x 4 red board, and adapt Chinese Checkers (or its square-grid antecedent Halma) so that players race to move 3 or 6 of their pieces from a corner orientation, through to the diagonally opposite corner, either moving one space at a time, or moving in a chain of connected "jumps" over appropriately positioned counters belonging to either player.

The potential for game invention, game adaptation, game analysis (tactical and strategic), and related investigations (computer simulation, handicapping, tournament organisation, and so on) is enormous. Why not introduce a dice, a spinner, a blue-yellow coin? What about pattern-making, permutations and combinations of red, blue or yellow plugs?

As well as the four members of the Noughts and Crosses family, Doug Williams also includes:

- versions of Nine Men's Morris; he calls this the Make and Take family of games;
- Fox and Geese-type games (where one player has, say, one counter, but can jump and capture, and another player has several counters but can only move and trap); and
- strategic race games (similar to Chinese Checkers or Halma) which he calls the Squeeze family of games, where one player races to move all of his or her counters across the board and off the other side, with possible capture along the way.

This is only the tip of the iceberg. Other possibilities include counter shifting and jumping games, such as the well-known Frog Jump-type game with different colored counters starting in a line, and players racing to move from one end to the other, or a single player trying to work out the fewest number of jump-moves needed to exchange counters of one color at one end for counters of the other color at the other end. What about a mini version of Go or Wei-chi, the Chinese game of territorial capture, played on a 5 x 5 or 4 x 4 board, as Herbert Kohl's remarkable book *Math, Writing and Games* (Vintage, 1973, p 147) suggests? What about coordinate adaptations? Or versions of Dotty Squares - players take turns to play one of their own counters in any empty spot, aiming to be the first to make a square whose four corners are occupied by their own counters (ignoring any counters of the opponent that may happen to be within the line between the corner squares) - don't forget squares that aren't necessarily parallel to the edges of the board.

What about one-person solitaire-type games? John Conway's "game" of "Life" and other forms of cellular automata? Permutations and combinations of different numbers of counters and colors in different configurations: think of triominoes.

In his article in *The Classroom Connection* vol. 4, no. 1, 1996 Doug Williams suggests still further possibilities. How many mathematically different ways can you have one hole in the 5 x 5 board? (Hint: first solve this for smaller versions of the 2 x 2, 3 x 3 and 4 x 4 board.) How many ways can you have 2 holes? A

square of adjacent holes? What about using the Blue and Yellow plugs as positive and negative numbers, and associated addition and subtraction, or even multiplication - and division? Triangle numbers. Square numbers. Fractions. Creating a number-sheet underlay for the holes in the red board so that further arithmetic work can be performed in a game or investigation format.

Finally, Williams points out in his article that, even though some of these suggestions boil down to little more than recognizably ordinary worksheet and board-and-counter activities, the actual fitting of plugs into their board-holes makes packing up, checking and maintenance of equipment a simple visual matter.

Clearly **Poly Plug Game Pack** offers immediately usable directed activities and open-ended materials for investigation - and great potential as stimulus material for your own further development!