mathrecreation

Wednesday, March 25, 2015

are you experienced?

Don't despair

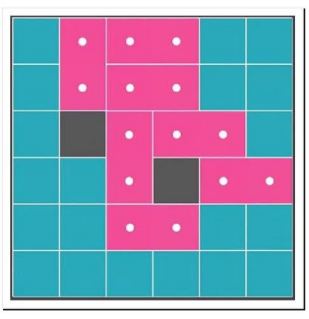
A search for "math" in the iTunes store is likely to disappoint (maybe "maths" or "mathematics" would provide better results). I haven't tried **Math Drills Lite -** it is likely the last thing I would want to download, yet it comes up first.

A sad situation

But this is happy post, because there is a math app, well, more of an interactive book, that is engaging, interesting, well written, and attractively designed, that conveys mathematics as its practitioners and enthusiasts see it: beautiful and creative, not dry and confusing. **Mathema**, written by two mathematicians, Hugo Parlier and Paul Turner, is an accessible math app/book for students, teachers, and general folk that seeks to provide its readers (interactors?) with authentic mathematical experiences that capture the process and feelings associated with doing mathematics.

What does doing mathematics feel like?

Structured around three core mathematical experiences, Mathema presents visually interesting puzzles and games, and then proceeds to introduce the math that can be used to make sense of them. Along the way, we get excursions into graph theory, metric spaces, algebraic structures, and other advanced topics (for a popular book), but always grounded in answering questions that naturally arise in each investigation.

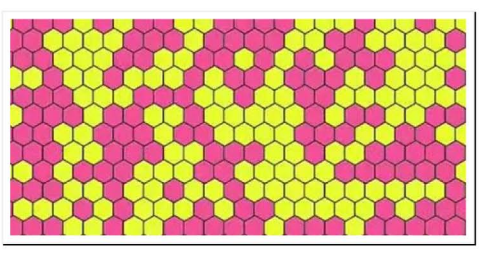


The Dominoes Puzzle: its solvabilty depends on where you put the holes

The first mathematical experience includes some familiar mathematical recreations made fresh by the interactive capabilities of the "book." The process of doing mathematics (encountering a problem, making a conjecture, using logical reasoning, and benefiting from some key insight) and the feelings of doing math (enjoyment, frustration, satisfaction) are presented through the "Dominoes Puzzle": can you cover a chessboard with two missing squares with dominoes without overlap or gaps? I shared this part of the experience with a ten year old, who enjoyed trying to cover the board missing corners with the dominoes, agreed with the hypothesis that it was impossible after trying it a few times, and then listened to and understood the proof that explained why it could not be done. I'd suggest that the target audience for the rest of the book is a bit older, but it was very nice to see how well and simply this first part of the book accomplished its goal.

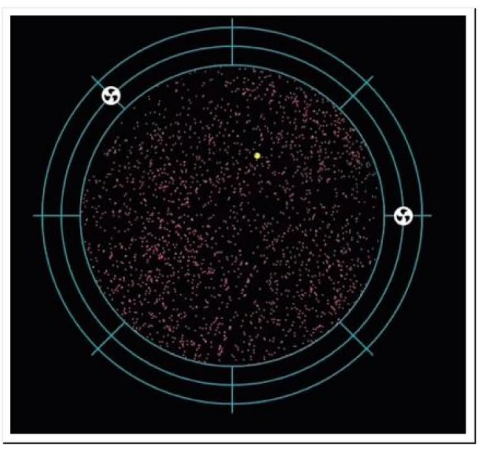
Mathematical Games for a new generation

The Dominoes Puzzle might be familiar to some as the "mutilated chessboard" problem from Martin Gardner's first Scientific American collection (problem 3 in *Nine Problems*), but the presentation in Mathema is much more complete and inviting. Actually being able to place the dominoes on the virtual (unmarked) chessboard is a great advantage of the ebook format (no chessboards were harmed, no actual dominoes required), and being able to move the holes around extends the puzzle meaningfully. The first experience also includes an explanation of why the game Hex (also written about by Gardner in his first book of Scientific American columns, who tells us that the game was co-invented by Piet Hein and John Nash) can always be won. Here again, the interactive nature of the book is used to advantage. Back in the 1950s, Martin Gardner suggested to readers that a Hex board of their own "can easily be drawn on heavy cardboard or made by cementing together hexagonal tiles." The software version of Hex in Mathema beats cardboard and cement, and being able to quickly generate many complete honeycomb patterns leads naturally to the hypothesis that you will always have a path from one side of the board to its opposite.



A portion of a Honeycomb pattern: these tell us about the winnability of Hex

The "chroma square" puzzle of the second experience is suggestive of a two dimensional Rubik's cube, and learning the trick to solving them quickly gave me an unreasonably great sense of accomplishment. The idea of treating these puzzles as mathematical objects and considering the space of all chroma squares is well presented, and the excursion into abstraction is repaid when the method for solving the puzzle is used to prove a couple of interesting things about all possible chroma squares and how they relate to each other. The third and final mathematical experience allows you to play with a more dynamic system of "flows." At first flows seem to bear little resemblance to the puzzles of the first two sections, but Mathema shows that by a thoughtful process of making definitions, these too can be analyzed using mathematical thinking.



Fans blow particles within a disk creating a flow

Why does it work?

The visual and interactive way Mathema is designed, with its scrolling, flipping, and zooming, is a significant part of its appeal and its ability to engage. I think there are more important things that it does right that have nothing to do with technology, however. How the authors understand authentic learning experiences is key. What is "authentic" math? - the mistake that some people continue make is to assume that to make mathematics interesting and relevant it must be connected to some practical or real-world application. Puzzles, patterns, games, and aesthetically interesting images are the real hooks that make math interesting, and understanding this is part of Mathema's appeal. Another thing Mathema does right is recognizing that mathematics is most relevant and interesting when it is presented in a non-curricular way: not as topics that are isolated from each other and blocked off from amateurs, but instead as a way of making sense of the world that is available to anyone who wants to use it, and applicable almost anywhere.

Posted by Dan MacKinnon