MazeFire Games: Best Practices for Teachers and Professors

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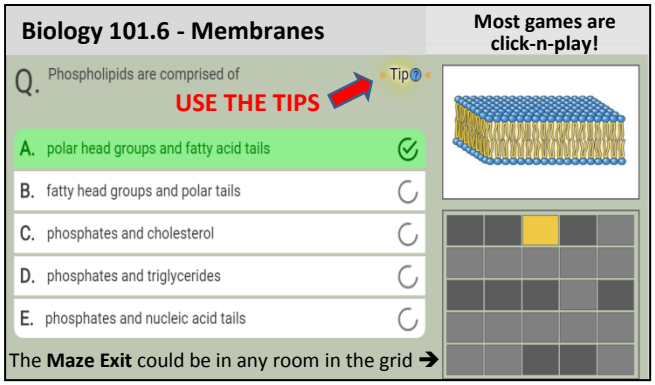
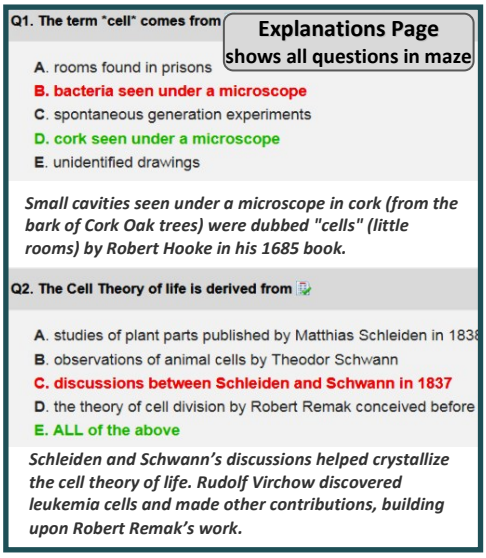
Overview: MazeFire Games are dead simple for professors and teachers to use and can make your classroom a tad more fun. Our *Semester Paks* (10-maze collections) sample primary content from across a typical semester of e.g. Bio101 or Chem101 and will substantially overlap a teacher's syllabus, while also enriching the student experience. Each Semester Pak contains ~200 questions and instructors are encouraged to use our questions in their quizzes, exams, labs and review sessions: you can ping us for an *Instructor's Pak* that includes all Q&A along with explanations. Most of our 115+ maze games are free and so you can just click on a game in class and your students will immediately STOP everything else they are doing and pay attention! Mazes are great as pre-tests and icebreakers at course outset, while also providing engaging review-challenges when studying for mid-terms and finals. MazeFire's #1 goal is to make our content 100% accurate so that our games can serve as reliable instructional-multipliers that boost students' depth of knowledge and the integration of knowledge into each student's world view.

Playing Games: Students can immediately play most maze games, without instruction, just by clicking. Registration is required only to purchase and play our three current VIP Paks (Micro200, Neuro200 and A&P-II). There are also some free Neuro and Physiology games on the site, which you can see by scrolling the ALL MAZES tab. Our Student Guide is available at zfhindbrain.com (http://bit.ly/1Ukc3E4) and offers tips and strategies for students seeking to get the most out of these study-multipliers. Below we provide best practices for in-class and at-home play as well as some details on the cognitive advantage of the Digital Maze learning environment.



MazeFire Games are Instructional Multipliers: Each Semester Pak samples content across a standard semester of e.g. Biology101, Chemistry101, etc. While levels of instruction and teacher emphasis do vary, the core knowledge needed to become fluent in such disciplines is essential for academic progress. It is certainly true that a student who knows all 200 questions (and explanations, shown at right) of e.g. Bio101 will be far better prepared than one who knows none of it. The beauty of having a trusted, click-n-play academic resource at your disposal, is that you the teacher need do nothing more than say "Google MazeFire"—you do not even need to send your students a link. Teachers and Professors are very busy, and while additional games and custom modification are further options, our goal is to make your teaching easier and better. By offering students a *game* to explore, you immediately boost *curiosity* and *motivation* much more than most other course supplements. Once inside the Digital Maze, students must think their way out: they cannot complete the game until they figure out the right answers, and



we boost their knowledge and understanding all along the path. At the maze exits, we further leverage their heightened motivational state by providing feedback and explanations. These are precious learning moments and the Digital Maze algorithm is uniquely capable of engaging neocortical processes to correct misconceptions and detect/fill knowledge gaps, thus boosting cognitive advancement. Our games are rooted in Synaptic Learning Theory (see below), but we first summarize some fun ways that DM Games can be employed.

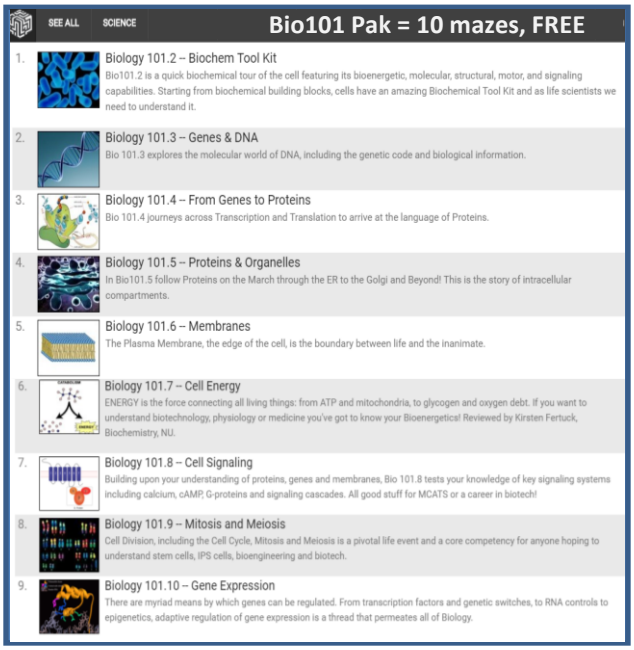
In-Class Play: Originally conceived as a textbook supplement, MazeFire games have proven equally valuable for in-class and dorm-room play. Students love an occasional game-break, and this active-learning approach has garnered teaching awards for several NU professors. Just go to MazeFire.com and click any maze to begin playing (Instructors get free access to all MazeFire games, so just ping us for VIP access). *There are 5 fun variations of in-class play:* didactic mode, group play, individual, whole-class and high-tech. In didactic mode, the teacher projects a maze and then asks students (aka "volunteers") questions to see what they do and do not know: this is an engaging way to find knowledge gaps and discuss key concepts. In medium-to-small classes, we initiate group-play by saying "you guys are Group 1, you over there, Group 2 (etc.); Group 1, you now control the maze". At some point after a group makes a mistake, control can be passed to a new group, and the other groups stay involved via peer-to-peer discussion, because they may see some of the same questions again (and won't necessarily know the correct answer). The group that completes the maze might win a small prize (candy bars are very popular). Each turn and each question provides new opportunities for both class-wide and peer-to-peer discussion. During individual-mode, individuals (or pairings) can play on their own device and the first to shout the maze *Completion Code* wins. However, if wireless bandwidth is limited, this might not work well. In whole-class mode the teacher projects the maze on the board and class-wide navigation is used, which could just be a show of hands (easiest) or color-card polling (for maze sessions, each student brings 5 color-cards that correspond to answers A,B,C,D,E). Volume-controlled navigation is fun, where students shout out letters and the letter that is shouted the most/loudest wins. One High-Tech polling option is to use "clickers" which are nice because the teacher sees exactly how many are choosing each answer and then selects the favored answer (or intervenes for didactic reasons). While the persistent clunkiness of clicker technology has limited its popularity to date, this should improve and nicely complement Maze Technology. In the mean-time, low-tech color-card polling accomplishes much the same thing.

Dorm-Room Play. For in-class maze-play, professors are limited only by their imagination, which applies to at-home (or dorm-room) play as well. Mazes can be assigned for credit or extra-credit to encourage play. Because each Semester Pak contains about 200 multiple-choice questions (which cover key elements of the designated topics), these are a nice resource that instructors are encouraged to use. If students know they will be seeing maze-questions (or variants) on an upcoming exam that greatly boosts motivation (and synaptic reward systems) to acquire and apply knowledge to reach the maze exit. Teachers can also pretest students by assigning mazes and seeing how they do, by e.g. asking students to submit the *Completion Code* found at the maze exit. Teacher Tools to track individual players are not yet implemented, but MazeFire can provide some class-level metrics right now (see page 4). Maze games can, of course, be optional study materials for upcoming mid-terms and finals: our mazes are challenging (we prod students to think), but students do spontaneously play together to find the maze exits. They are interested both in learning and in the rewards of seeing answers (with associated explanations) that will be on upcoming exams. This is a powerful motivator and students much prefer this over re-reading notes and textbooks.

Why MazeFire Games? Three reasons: Learning Algorithm, Rewards and Simplicity. These three elements distinguish MazeFire from other teaching/study options. First, our Learning Algorithm is unique in that we do not tell students the answer. Conventional pedagogy tells us to ask a question, then answer it. But students already heard the Q&A and still got it wrong. Why? Our brains are not flash drives to which we can write encyclopedias. The 20 billion processors (neurons) in neocortex need time and reward (neuromodulators) to accommodate NEW concepts and details into their existing, massive, highly-interconnected knowledge systems. As multi-sensory information flows along bottom-up pathways into nascent representations, our hippocampal memory and sequencing systems work with neocortex to acquire and integrate new knowledge into existing constructs. Neocortex has 20 billion neurons engaged in SubConscious Information Processing (SCIP) and the time spent exploring Digital Mazes gives SCIP time to do its magic. Teachers know that time spent reflecting (e.g. pondering Tips, Images, Questions, Answers and at-hand-resources) is a good investment because every teacher (we've met) agrees that it is important for students to think about what they DO and DO NOT know.

The Digital Maze algorithm is made even better by our neural Reward Systems. All vertebrate animals have an innate drive to navigate, i.e. to solve maze puzzles: this was an existential matter for our ancestors and getting lost today can still get you killed (albeit rarely). Your *intrinsic drive* to find the maze exit is *amplified* by *extrinsic rewards* provided for specific mazes, such as course credit, extra credit, or practice questions that may be on an upcoming exam. These rewards are implemented by such neuromodulators as dopamine and serotonin which boost synaptic learning processes and create enduring, robust memories [while synaptic/circuit details are beyond the scope of this essay, they are crucial]. Games are immediately motivating to students, and the greater the applied rewards, the more likely students are to invest the time and focus needed to advance cognitively. Students want to do better on exams and be well-prepared for upcoming courses in their academic progression (not to mention standardized tests like SATs and MCATs). For professors, however, Simplicity is our founding principle: you need only send your students a link, and they become "*65-pages of primary-knowledge*" better on the topic YOU are teaching (65 pages is the average length of our *Instructors Paks* - ping us for a free copy). *Simplicity* is reprised in next section.

Didactic Structure. Two main questions regarding MazeFire content are (i) What does a Semester Pak cover? and (ii) How does this fit into the larger curriculum? For ease-of-use, aka Simplicity, MazeFire creates 10-maze Semester Paks that attempt to incorporate the most essential facts and concepts across e.g. a semester of Bio101. It is unlikely that any two professors will be in perfect agreement on all points, but a skim of each Semester Pak's contents (available free to teachers as *Instructor Paks*), shows that what we have in common far outweighs our differences: certainly genes, proteins, and membranes are essential for understanding cells. Our *Semester Paks* will challenge most students to think about what they do and do not know, but we also provide TIPS and other clues with the goal of ensuring that most or all students reach the maze exits, and reap the rewards of the Explanation Pages. In turn, teachers can leverage maze



content by telling students to read Chapter X or pages yy to zz so that the students can complete the maze and see upcoming exam questions. Also, some teachers/professors may want to provide different maze content to their students, which we can accommodate. If a current Pak is too difficult, we can create a preparatory "Paklet", e.g. 5 mazes of **Bio101 Prep,** that includes key vocabulary and the most basic concepts needed to tackle the Bio101 Semester Pak proper. If desired, we can also create mazes and collections with more advanced and specialized content. Currently, we do not have an option for teachers to modify current maze games/paks, but this is coming soon. This would be most helpful where an instructor feels that our mazes are missing some key points, or if they would like to tweak questions and answers to better match their perspective. Teachers might also like to add content to the explanations and TIPS, e.g. reading assignments or cool items from their experiences. This is a plus for students, but our starting position is to offer Paks where teachers need not do ANY extra work, because one point where we can all agree is that we all have enough work to do as it is! MazeFire is indeed Simplicity personified.

The second item at hand is Curricular Structure. While there is a frenzy of activity to meet standards of every ilk, MazeFire understands that there are certain core elements of biology, chemistry, physiology, calculus, physics and other major disciplines that are simply indispensable. Our focus is therefore on building useful knowledge foundations and encouraging robust knowledge integration so that students transition from "remembering" to "knowing". The BEST exam question, from a student's perspective, is when she sees a question and she immediately *knows* the correct answer. Our initial emphasis is on STEM subjects and our goal is to help students progress from the High School level through the MCATs and Graduate Record Exams and/or into positions of industrial competence. From this vantage point, a single Pak, like Bio101, can aid AP Bio students, help with SATs, help freshmen to get an A in general biology, provide fun *refresh & review* for upper level bio courses, and help them to become a project leader in a Biotech startup or Big Pharma. True knowledge never grows old. But these are early days and MazeFire is just beginning to build a structured sequence of science and other maze games. This will provide an organized repository of study/review materials that maze players *can easily return to* so as to reinforce prior knowledge, add new tidbits from the *Explanation Pages* of earlier mazes and try out new mazes that they discover. MazeFire has just begun to build its game collections and we can easily import content for any level or topic in academia: new authors are always welcome!

While simplicity is of great appeal to teachers, many teachers would like to track student progress and better understand where their class is on each maze topic. The next section describes new features in the works that will enable customization and assessment, while providing new player rewards that will boost student engagement.

New Features (pending): Most games are free so students (and teachers) do not need to register: *click-n-play* is what we like. But to check student progress and assess class-wide performance, several new features will be nice (and will require students and teachers to login). At the moment, students can simply email a *Completion Code*, found at the exit of each Maze, if the teaches wishes to monitor completion. MazeFire can also provide overall maze completion rate-estimates, giving a general sense of class performance (while also providing a cross-check on student reported completions). But essential new tools are under construction and should be released before too long, in conjunction with a major site upgrade expected in late 2016.

MazeFire 3.0 will feature new **Teacher Tools** and additional **Student Rewards.** The *Teacher Tool* dashboard will allow teachers to conveniently observe usage of maze games at both the student and whole-class levels. Students beginning a Semester Pak will be matched with a corresponding

teacher (by e.g. email suffix) and so the Teacher will automatically get to see the performance of all of their students, organized alphabetically, or by time of completion if e.g. running a competition. Class summary reports will show Questions with Answer choices, including the number choosing each answer, thereby identifying concepts where the class continues to struggle. MazeFire is NOT intended for high-stakes testing, but rather for fun-practice and group-study, so we do not shuffle answers or implement other grade-authentication controls.

One coming feature that should be of value will be our *Maze Editing Tools*, where teachers can edit questions, answers and explanations, if they wish to modify/enhance MazeFire's content to better reflect their emphasis and perspectives. This can also be done to correct errors or confusing passages, but we always ask that such issues be brought to our attention and we will correct them in the source mazes. In any case, students who select your class will be seeing your version of these maze games, should you choose to make edits. Teachers might also like to add brand new mazes and they should contact us if they wish to add to our collection in exchange for compensation or royalties.

Student Rewards. To make our games more appealing to students, we will also be implementing *Badges*, *Certifications* and *Leaderboards*. While many students already enjoy the challenges posed by our maze games, the implementation of leveling, unlocking new mazes and other "gamification" tweaks will boost appeal and completion of games that you assign. Teachers can also compete with one another in the teachers lounge, or better yet during faculty meetings! Another planned feature is organized multi-play, where students (or teachers) explicitly play against one another as e.g. in the games Trivia Crack or STOP/scattegories.

Precis of Synaptic Learning Theory (SLT). All brain-learning mechanisms are synaptic. Whole-brain imaging studies (aka fMRI) have become a popular means to identify brain regions that are involved in different neural operations, but we should keep in mind that fMRI is essentially a spot-light, from 10,000 feet up, and reveals no circuit-level details. All brain operations are computational in nature and such operations occur at the level of synapses and local neuronal circuits, albeit within the context of larger neural networks. In trying to understand the storage of new information in brains, we need to follow incoming information and understand the synaptic mechanisms (including LTP, LTD and neuromodulation) that are able modify existing neuronal circuits. SLT is concerned with how incoming knowledge is organized (invariant representations), how such packets are routed through neocortex, and how they are used to make new connections within previously-stored knowledge architectures (which often take the form of auto-associative networks, AANs).

There are two very different forms of memory, short-term working memory (WM), which is focused, effortful and limited to just 7 +/- 2 items, and our daily memory records (DMR), which is a day-long, huge-capacity chronological store that is stored effortlessly on a one trial basis. The hippocampus (involved in spatial learning and sequencing) works with neocortex in these memory processes. According to zfhindbrain.com, which is the main repository of SLT & DMR analysis, all episodic memory and declarative knowledge enters our brains as DMRs and is initially stored in neocortex, taking advantage of the representational capacity of our 20 billion neocortical neurons. Others view the hippocampus as the initial transient store. But in any case, what is clear is that the more connections that can be made between existing AANs (e.g. via multimodal instruction), the better integrated and robust our knowledge stores will be. We also know that excitement and motivation boost ACh, dopamine and other synaptic-reward mechanisms making memories stronger. But the truth is that SLT is in its infancy and MazeFire is very interested in advancing this field.

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