Photo: Fotolia/ TheSupe87

Online science games

The Power of Playing

Online science games are not just for killing time in your incubation break or on a lonely evening. You can also help other researchers with their scientific problems. Or simply fool around with science-related stuff.

You surely know those awfully addictive, flash-games; the type you stumble across when all you want to do is look up something on the internet or check your emails. Once started – all it takes is a "quick look" at the type of game – it's very easy to end up playing for hours without noticing how quickly the time has disappeared. And without having done any real work.

To give you a cleaner conscience, there are real alternatives. But these are almost as addictive as moving diamonds around a warehouse, collecting golden coins in a dragon's realm, or shooting up space shuttles in the outer reaches of the universe – not to mention Pacman. Games with a purpose, called GWAP, come in the form of "normal" online games, with the exception that you can in fact contribute to science while wasting your time playing them.

More fun than preparing buffers

Sure, it's not your own project but helping out others from time to time is a nice gesture, too. Especially because it is far more fun than, for example, preparing buffers for your colleagues or shutting down their machines; favours you do for them every day, already.

When playing GWAPs, you'll help a bunch of enthusiastic researchers that didn't shy away from turning their project into a mode that allows nearly everybody to join in. All the helpmates need is a computer and a browser. And… time.

One of the first, almost classic science games now was and still is "Foldit". Foldit was first released in 2008 by a bunch of researchers from the Center for Game Science in collaboration with the Department of Biochemistry, both at the University of Washington (*Nature,* 466:756-60).

Playing Foldit means you are either creating new proteins or fold existing ones into an energetically favourable state, even without knowing anything about proteins. Achieving those protein structures – by using the different tools of the game to turn the protein, to zoom in and out, to shake or fix side-chains or to pull parts of the protein and drag it to another position – might one day help, for example, to fight diseases like HIV/Aids or contribute to finding new types of cellulases that break down plant material more efficiently for the production of biofuel.

Foldit uses the creativity and resources of people all around the world, who are mostly not associated with science. About 240,000 players registered for the early beta-version of the game in 2008.

Indeed, the gaming skills of Foldit players have already led to one or the other publication. For example, some of them generated models of the M-PMV retroviral protease. These models were finally of "sufficient quality for successful molecular replacement and subsequent structure determination" and allowed scientists to design novel, anti-retroviral drugs. What's even more surprising, the players beat several researchers, who had tried exactly that structure-solving task many times before (*Nat Struct Mol Biol*, 18(10):1175-7).

Better than computers

But why still put humans in front of computers? Can't the "calculating machine" do all the work by itself? The answer is no. And that's because humans are still way superior at recognising visual patterns compared to computers. Playing Foldit, therefore, is a bit like playing chess against the computer in the early days of video games. The addicting challenge consists of beating the machine, however long it takes you.

Another science online game along the very same line is called "Phylo" (*http://phylo.cs.mcgill.ca*). The aim of Phylo, mainly

realised by researchers from the School of Computer Science and McGill Centre for Bioinformatics in Montreal/Canada (*PLoS ONE*, 7(3):e31362), is to align two or more DNA-sequences that have already been aligned by computer algorithms but can still be improved. The gamer's job is to shift and move little coloured squares, representing the four DNA bases and arrange them in a way that would finally achieve a higher score than the computer algorithm. You get one point for each match and lose one for mismatches, an extra penalty for opening a gap and another penalty point for each additional nucleotide that is missing in the gap.

"Played by Humans, Scored by Nature"

Tough job? Indeed. But as computers calculate the multiple sequence alignments with heuristic algorithms – meaning to work efficiently with limited capacity in a certain time – there is a real chance that people can indeed do better than computers. When you finish one of the levels you will even get a short message stating for which purpose you've played the stage. Some alignments, for example, are aimed at helping scientists find a cure for the inherited heart disease familial, arrhythmogenic right ventricular dysplasia.

Those who prefer to work with RNA rather than DNA might want to check out "EteRNA" (*http://eterna.cmu.edu*), conceived by Carnegie Mellon University and Stanford University. EteRNA is a science online game, in which players create new RNA sequences, tinkering with the four bases to find energetically stable structures like hairpins, stacks and loops. RNA is also one of those molecules, which – in the right conformation – might one day contribute to medical progress.

The problem, however, is the same as with proteins: how to fold it in the most efficient way. The dream of EteRNA's developers, therefore, is "[...] that within a year or so we will be able to create RNA that is functional and that we can transcribe into cells to do things such as sense light or even deactivate a virus," as Rhiju Das, one of the designers of the game, put it in a *New York Times* interview. And the developers enthusiastically add, "By interacting with thousands of players and learning from real experimental feedback, you will be pioneering a completely new way to do science."

Patience for Kudzu

With its dark blue background and shiny soap bubbles, EteRNA looks like a space game. Strange stellar constellations called "The Thinker", "Kudzu" or "Water Strider" are RNA shapes you have to create with the correct pairwise alignment of bases. You'll need a lot of patience for this! Check if the constellation folds as you have intended and if it is energetically reasonable. If not, change bases as to how you think (or as you know from the tutorial) they might be better collocated and check again.

At the beginning of the game you might feel like a lab assistant, especially if you want to play the higher levels right from the start and learn that you first have to gain 10,000 points before becoming a real lab member, who is allowed to create new structures that might even be synthesised

Sydney and Spike, two non-Creationist platypus scientists help you refresh your cell biology knowledge in CellCraft.

at the developers real labs in Stanford. The EteRNA community can choose, which result represents the most promising structure of the week. The winning structure will be produced and checked *in vitro* and – depending on its actual quality – awarded with between 0 to 100 points and possibly gain entry into the researchers RNA library. This connection to real scientists and science makes EteRNA even more challenging and quite addictive, even though it is somewhat awkward to play and is one of the "calmer" games.

Lessons from an amoeba

There are, however, other games that might give you the impression, you are playing a real game because they even include short action sequences. One of them is "CellCraft" which, for example, features an insidious robot fighting the "organic weaklings". CellCraft, therefore, has a real flash game feel to it and that's not all it has to offer. As a player, you get into some exciting situations that might even wake you up from your boring work routine. And besides all this gaming fun, you can refresh your cell biology knowledge.

The – sadly a little lame – story goes like this. Sydney and Spike, two platypus scientists, learn from the newspaper that a giant meteor is heading towards Earth. They realise that somehow they have to save their species' genes. In two shakes of a platypus' tail, they get a "ridiculous amount" of grant money to raise an amoeba. If they manage to successfully insert their own DNA into the amoeba's genome, they will be able to send it off for a long, long voyage to another safe planet, called E4R1H.

CellCraft starts with a loading bar. Nothing special here but in this case it's a test tube filling up with toxic-appearing green liquid. After that you see a microscopic detail of a petri dish, with a single cell in it, the amoeba. You have to care for this little critter throughout the whole game: stroll around with its pseudopods, find and take up nutrients as glucose or amino acids and nucleotides for its metabolism, gain organelles like mitochondria, peroxisomes, chloroplasts, ribosomes and ER.

Because you just somehow gain these organelles – the platypuses or whoever always provide you with them pursuing a certain purpose (there is light, so you need chloroplasts to use it!) and, moreover, always in the right moment (now there is light!) – some scientists have strongly criticised the game as being creationistic and spreading ideas of intelligent design. Moreover, the organelles do not evolve during the whole game and, in the end, it's the intelligent platypuses who want to insert their DNA into another organism in order to colonise a new planet. In fact, the game was also partly supported by two self-confessing creationists, namely Jed Macosko at Wake Forest University, Winston-Salem, NC, and David Dewitt at Liberty University, Lynchburg, VA. On the other hand, one of the programmers contradicts in the CellCraft forum, "Despite the private beliefs of some people on our support team, CellCraft is NOT intended to be a 'Creationist' game."

Sick platypuses and evil robots

Anyway, at least for dedicated scientists the game should not pose any danger to their scientific conviction and turn them into followers of intelligent design. But it might not actually be the best game for school lessons. If you nevertheless want to try this game, you (or your cell) from time to time will have to fight against free radicals or viruses, either because one of the platypus scientists sneezes on the petri dish or because the evil lab robot infects it on purpose. Levelling up, you will encounter newer and more effective virus strains that are ever harder to beat. Playing this game, you will finally not only be training your gaming muscle but also your "thinking

If you're still not tired of lab work when you get home, try doing some virtual research in the Power of Research.

muscle", or at least its learning and memory centre. So you will learn or recall, for example, that mitochondria use one molecule of glucose to produce 38 ATP molecules or that slicer enzymes kill viral RNA.

Virtual research

At several levels, you can make your cell fit for the trip into space and learn about the costs – measured in ATP, nucleic acids or amino acids – to keep the cell healthy and alive. Altogether, the game is actually a nice attempt to playfully teach gamers more about the cell and give them a sense for how fragile a single cell can be. Nevertheless, apart from the strange platypus-scientists there is still another really annoying thing about the game – the droning music.

Finally, a completely different kind of game is "Power of Research" (*www.powerofresearch.eu*), which was funded by the European Union and put into effect by two companies from Vienna, Biolution and TPM Games. You can play Power of Research either in a virtual research lab or in a virtual hospital.

As a researcher you can choose on which topic you want to work throughout your virtual scientific career from fields like, for example, infectious diseases, cardiovascular system or cancer. "With the Power of Research, we will allow players to virtually slip into the role of scientists and experience everyday real research," as Iris Grünert from Biolution explained in a press release. That means that you will do all the work you might know from your real life as a researcher: DNA isolation and cloning tasks, protein purification, cell cultivation or microscopy as well as manuscript publishing. Moreover, you can become the leader of an institute, who has to run the whole business – managing lab resources, paying staff, securing funding and so on.

If, however, you choose another path and play a physician, it will certainly be your task to treat patients coming to the hospital. That means, you'll make diagnoses using x-rays or ultrasound and develop suitable treatments. Depending on the case, you might even find yourself performing surgery.

Power of Research's intention, therefore, is to help young people obtain an insight into real scientific work. However, it also harbours a certain fascination for real researchers. Playing Power of Research might give you the opportunity to "jump over the fence" into what other groups' labs do and, therefore, provides you with the opportunity to try "another researcher's life". This way, you can play the game over the course of several weeks or whatever period you like – either inviting your real-life labmates to join in or simply advancing as a "lonesome lab hero".

Rest for success

So, at the end of the day, it depends on you, as to which type of scientific online game you choose. But maybe you are already rather fed up with staring at a computer screen and lab life in general? In this case, games without a purpose, like playing cards, or simply having a creative rest could also contribute to the success of your own work in a much more remarkable manner.

Valérie Labonté