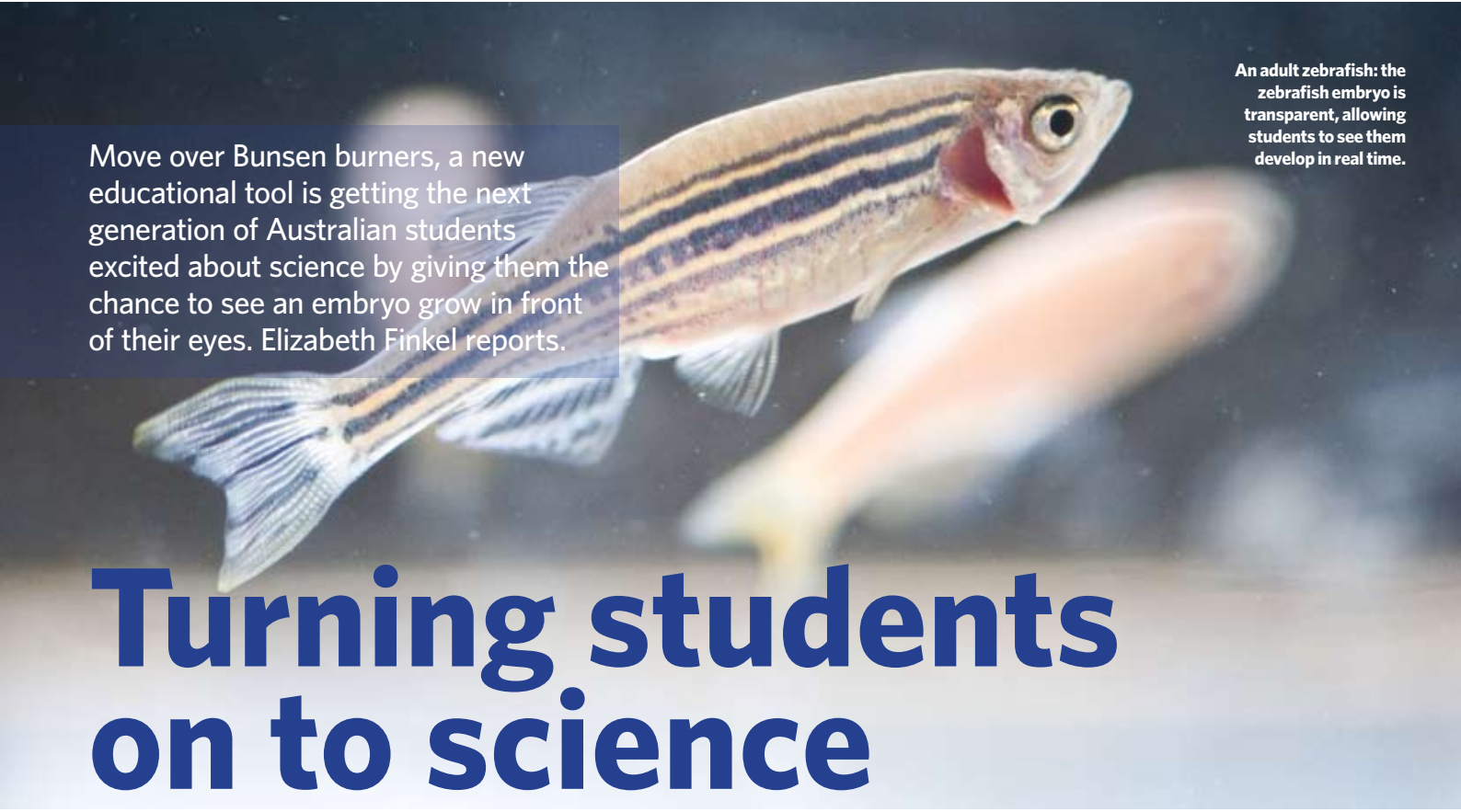


An adult zebrafish: the zebrafish embryo is transparent, allowing students to see them develop in real time.

Move over Bunsen burners, a new educational tool is getting the next generation of Australian students excited about science by giving them the chance to see an embryo grow in front of their eyes. Elizabeth Finkel reports.

Turning students on to science

IT'S A PARADOX. Science is about exploring the wonders of the universe, yet studies show that by the time students reach high school, many find the subject boring. Perhaps the vintage Bunsen burner – that curtain-raiser for laboratory science – has something to do with it?

How then to impart the awe and wonder of science back to jaded students? Enter BioEYES. BioEYES is a science activity based on the development of the zebrafish – a creature that has been causing lots of awe and wonder since it made its debut in labs a decade or so ago. Seeing these little striped fish swimming around the tank, it might not be obvious why. It's when you see their eggs that the awe hits you. They are transparent: all the wondrous events that transform a yolky one-cell egg into a swimming fish take place right in front of your eyes.

Whether it's man or fish, watching the development of a mushy egg into an embryo is like a scene from Walt Disney's Fantasia. Imagine a house pouring its own concrete foundations, beams of wood hoisting themselves into a frame, bricks stacking themselves neatly into walls, pipes and wires cleverly threading themselves through the growing structure. The metaphor goes a small way to conveying the fantastical feat of an embryo's development. Many embryo-watchers have been filled with awe. Aristotle cracked open chicken eggs to watch the process. The 19th century German scientist Hans Driesch was so awe-inspired it drove him to mysticism.

So far, more than 34,000 American students have not been driven to mysticism but they have been turned on to science through the BioEYES program. During National Science Week last August, the Pennsylvania-based creator of the program, Jamie Shuda, was in Melbourne to teach BioEYES to year 10 students at John Monash Science School (JMSS) and year four students at Bentleigh West Primary School. Bianca Lim, a student at JMSS, certainly did not find it boring, "It was really exciting. We got to raise our own fish and we saw proof that genetics really works. We don't normally get to test theories." A couple of days later, sitting in the school's cafe, the confident Lim was reciting the stages of zebrafish development as easily as a times table.

JMSS does not look like your average high school. With its sleek lines, open-plan interior and ultra modern furnishings, it looks like any other of the new research institutes rising out of the Monash University Clayton campus. Indeed, in a way, it is an experiment about how to bring the coolest science into the class room. The Monash University scientists are very excited about BioEYES.

Above: students record their zebrafish observations.

Below: the Pennsylvania-based creator of bioEYES Jamie Shuda after the presentation.

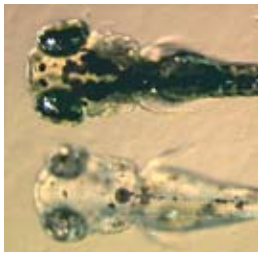
The university and two associated institutes, the Australian Regenerative Medicine Institute and the Australian Stem Cell Centre, contributed to funding the project.

ON AN EARLY Tuesday morning in mid August, Anna Burke, the federal parliamentary member for Chisholm, launched BioEYES. Later, watching the program in action she enthused, "The future of the country relies so much on what is happening in this room." The federal government contributed $9,900 to the BioEYES project. They view it as a pilot they hope will spread to other schools through collaborative programs. Just as schools share a hockey pitch, the skills and resources to teach BioEYES could be shared with teachers who would otherwise be daunted by the science.

The main action takes place in a state-of-the-art classroom laboratory. Some 50 students are seated on stools at six rows of large white benches. Each bench is fitted-out with sinks partnered by high-arching chrome taps and microscope stations. Hovering around the class are lots of observers, including Bob Williamson of the Australian Academy of Science and scientists from the Australian Stem Cell Centre and Australian Regenerative Medicine Institute (which provided the zebrafish).

Planted in front of the wide array of students, Jamie Shuda is a small but powerful presence. She is pretty, with waist-length straight, dark hair and she doesn't look terribly much older than the students. But she has no trouble commanding attention. She discusses the fundamentals of what the students are about to do in a clear, interactive way.

The mini-lecture spans from a discussion of the human genome project – a read-out of the entire



Above: a pigmented zebrafish embryo (above) and the albino zebrafish embryo (below).

Below: Jamie Shuda talks to the students.

set of human genes – to a focus on the genes of zebrafish. The outwardly different species actually carries very similar genes to us, so studying the functions of zebrafish genes will help scientists decode the functions of their human counterparts. The students will use their own powers of observation (hence BioEYES) to learn about the genes of zebrafish. The previous day they set up a mating between a normal pigmented fish and an albino. Today they will inspect the offspring under the microscopes.

After the briefing, the students mill around their microscope in groups of three peering at their developing fish babies. Their neat notebooks record earlier events. For instance 15-year-old Yushara Wijerathna noted, "The female has begun to swim frantically around choosing the mate." They observe that the embryos have started to divide or cleave, forming something that looks like a transparent bunch of grapes on top of the yolk. More than one student notes how the embryos are very similar to the human embryos they remember seeing on television or the Internet.

Megan Munsie, a scientist at the Australian Stem Cell Centre, will confirm the truth of that impression in a few days time when she gives the students a lecture on the development of human embryos. Munsie is a scientist with a world first in her track record: in 2000 she was the first to achieve therapeutic cloning of a mouse (she cloned a mouse embryo and then made embryonic stem cells from that embryo). But public outreach is clearly her thing. The students will also hear about the ethical dilemmas of embryonic stem cells from the horse's mouth. Former MP Kaye Patterson drove through the bill to legalise therapeutic cloning in 2006.

Students watch their zebrafish breed – one parent is pigmented and one is albino.

Above: a student gets a closer look. The embryo will either be pigmented or albino, depending on its genes.

Right: scientists and teachers look on while the students monitor their growing zebrafish.

Now a professorial fellow at Monash University, she will also talk to the students a few days after the BioEYES workshop.

After the students spend some 20 minutes observing their transparent cleaving embryos, Shuda takes the floor once more. She asks the kids to discuss what they saw – it's a bit like pulling teeth. Then she puts it all together for them.

Some of them had seen dark embryos – they had not been fertilised. It was the transparent ones that were fertilised and dividing. The epicentre of the dividing cells was the top of the yolk, resulting in what looks like "a crazy hat forming on top of the yolk". Shuda tells them, "That's the start of your fish. The next few hours are really dramatic; every time you look, you'll see something different".

It was too early for the students to discriminate between pigmented and albino embryos; that will appear in the next few days. Some students say they expect there will be more pigmented offspring than albino ones, because the pigment gene is dominant.

An hour is up and the students pack up and shuffle out to their next class. Shuda helps stack away the fish, and then we sit at a bench for an interview about the program's beginnings.

BIOEYES TRACES ITS origins to Steven Farber, a young and enthusiastic geneticist at Thomas Jefferson University in Philadelphia. In 2002 zebrafish promised to open new vistas in Farber's search for genes important to digestion. Not only could he find fish embryos that had digestive problems, he could also find the genes responsible – very likely genes that played a similar role in humans. The see-though fish embryos proved to be a hot attraction for visitors, especially children. When the Dean asked Farber to formalise his side-show into a public outreach program, he realised he needed professional help.

Help came in the diminutive form of Jamie Shuda, a primary school teacher who had decided to do a doctorate in education. A family connection brought Shuda and Farber together and the synergy between scientist and school teacher was born. Shuda spent four years developing the pedagogy of BioEYES as a doctorate project. "I was the voice of what we wanted to get across in the classroom," Shuda told me.

Shuda's doctorate did not languish on a library shelf. It turned into a teaching module that not only inspires students, it empowers school teachers to bring cutting edge science into the classroom. Shuda adapted the module for both primary and secondary levels. The fourth graders tend to focus on zebrafish behaviour, like the way females chase their mates around the tank. The tenth graders learn about genetics. Interestingly, Shuda says it's the younger classes who seem to be most inspired. "They've got the raw curiosity." Young or old, Shuda says the students engage with their fish on multiple levels. "The student tends to bond with their fish; they never forget their BioEYES experiment."

Not only does the program engage students in science; it challenges the 'Google generation' with a different way of learning. Rather than getting information from a web search, the students have to patiently observe and inquire. "Often it's the student who isn't used to getting answers straight away who shines in the BioEYES class", she says. "I think it's important that we build these skills as well: we want them to ask questions and be good observers."

JMSS principal, Peter Corkill agrees. "We thought BioEYES was fantastic. For most students, science is a 45-minute session with test tubes. Our students saw some real science. This is a wonderful synergy between people at the cutting edge of science and the cutting edge of teaching. Our teachers got to see how the scientific principles they teach are being put to use in 2010."

For more information: visit *www.bioeyes.org* or contact michael.spiegel@monash.edu at the Australian Regenerative Medicine Institute.

Jamie Shuda helps the students understand what they're seeing as their zebrafish embryo develops.

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