Pixar In A Box Teaches Math Through Real Animation Challenges

Katrina Schwartz

Pixar senior scientist Tony DeRose was faced with a problem that animators had never solved — how to make the hand of an old man look lifelike. It was 1998 and he was working on the experimental short film “Geri’s Game.” DeRose needed to figure out how to make a sculpture hand model with many angular planes look smooth and skin-like on the screen. To do this he developed an algorithm using weighted averages that won him a Scientific and Technical Academy Award in 2006.

Pixar is constantly solving new technical challenges that allow its artists, designers and storytellers a broader range of movement and texture in the movies they make. Now the company is teaming up with Khan Academy to use examples like DeRose’s discovery of surface representation to show students how the math and science they’re learning in school is applied by Pixar animators.

‘At Pixar art and technology go hand in hand. It’s the interplay between the two sides that’s essential to what we do.’

Khan Academy is best known for its modular videos explaining various curriculum topics that students can use to better understand and practice a concept. But, like many other groups working on reaching large numbers of people through online video lessons, its content producers have discovered that lots of people stop watching partway through.

A combinatorics lesson shows how many kinds of robots can be made by animators with just a few parts. (Pixar in a Box)
When Pixar started looking around for a distribution partner, Khan Academy content producer Brit Cruise got excited that this partnership, now known as Pixar In A Box, might keep people interested in the content longer.

"The place we intersected was this need to pull people in," Cruise said. "I wanted to do better, but that required a paradigm shift."

The Pixar In A Box lessons start with a technical problem that animators face and work into the math from there. In each video a real Pixar animator lays out the technical problem, and then students get to experiment with interactive elements to better understand the problem. Gradually the video works towards a more explicit explanation of the math involved, and by the end the student is calculating to solve the actual problems faced at Pixar.

For example, in the character modeling lesson, based on the surface representation work DeRose pioneered, students learn about weighted averages. An animator lays out the problem DeRose faced and then students get a chance to play with 2-D and 3-D shapes, manipulating different functions to create midway points and move them in ways that might smooth the shape. As they play, they begin to intimately understand the challenge.

The lesson then turns to an explanation of why weighted averages help create the smoothing effect needed to make skin look more real. Students then return to the same tool they used before, but the math behind it is exposed, in this case simple algebra.

"They have this more interactive intuition lesson," Cruise said. "They're not just calculating."

He is also working to add hands-on activities to enhance the video lessons. Right now only two of the 12 modules have an interactive lesson, but Cruise is working with a group of teachers to develop others that can be done simply, in 40 minutes, with cheap materials.

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"We really are trying to intersect art and math, and you don't often see those things represented really well in hands-on activities," Cruise said. The hands-on activities are meant to push both the artistic elements and the math concepts a little further, challenging students to continue applying the information to more complex situations.

The emphasis on art isn't a coincidence. While the video lessons are currently about only math topics, Pixar In a Box producers are working on science lessons now (mainly computer science) and hope to make others for the humanities side of Pixar's work as well.

"At Pixar, art and technology go hand in hand," said Elyse Klaidman, director of Pixar University, an internal department that encourages Pixar employees to continue their learning. In school, math and science often seem completely divorced from the humanities, but at Pixar the storytellers, artists and sculptors must work hand in hand with computer scientists like DeRose, tasked with figuring out how to animate those ideas.

Klaidman said the creative demands of stories push the technical innovations that allow the studio to represent
those ideas, but just as frequently a new technical innovation will spur the storytellers and artists to dream up new things.

"It’s the interplay between the two sides that’s essential to what we do," Klaidman said.

The Pixar In A Box videos also do a good job of taking viewers inside the world of Pixar, into the offices and studios of real employees. And kids like feeling on the inside. "One of the things we found from eighth-graders was they were hungry for more of the Pixar personality," Klaidman said. "At that point we were focused on the content."

The videos show the people behind careers many kids have never considered. Students liked meeting real Pixar employees and getting a sense of who they are and where they work. This feedback prompted the content producers to add a "Getting to Know" section at the end of the videos, where viewers learn about the backgrounds of Pixar professionals and how they landed their jobs. The people featured in these interviews are intentionally diverse to help kids see themselves in many kinds of jobs.

While some teachers are already getting excited about the Pixar in a Box lessons, it's worth noting they were designed for the individual user, who isn’t necessarily a student in a public school. Cruise was clear that in order to make the videos feel authentic, they wanted to start from real technical problems Pixar has solved and explain the math behind them. Not all those problems are explicitly related to the Common Core, although some are. Every module has a lesson guide, which maps the lesson to Common Core standards when applicable.

Instead, these videos are meant to delight, to ask people to be creators as well as learners, and to push users to finish online lessons. Cruise said he hopes teachers might consider assigning the video lesson at home so class time could be used for the hands-on activities and a deeper dive.

"I honestly think you don’t actually start learning until that stage," Cruise said. "I’m a huge proponent of hands-on learning."

All the materials are free and the initial lessons are often suitable for all ages. The follow-up lessons are more grade- and standard-specific and range from fourth grade through high school.
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