



# Darwin builds better cars: Lessons evolving online vehicles

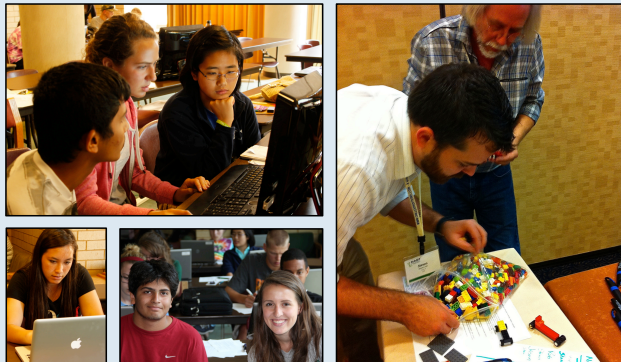


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## BoxCar2D: Discovering Evolution by Natural Selection Through Inquiry

Introducing students to the principles of evolution by natural selection in a fun, intuitive way can be challenging. We have developed a series of lesson plans that use the free, internet-based software (BoxCar2D.com), that incorporates mutation, reproduction with recombination, and natural selection to evolve vehicles that perform realistically on a diverse array of two-dimensional tracks. Students receive guided instruction to the software, and can conduct independent inquiry experiments to further test evolutionary principles.



With a video-game feel and a user-friendly graphic interface, this program gets students to engage with and observe evolution in action without realizing they are learning all the basics of Darwin's theory of evolution by natural selection – the biggest teaching challenge becomes getting them to turn the program off!

## Learning Progression: Evolutionary Principles

BoxCar2D is programmed to include many features of evolution by natural selection; however, without guided instruction, it is possible a student could miss these nuances. Our lessons help guide a student's understanding of evolution through a learning progression where they are first introduced to the major tenets of evolution by natural selection, and additional lessons build upon this knowledge to allow for inquiry projects.

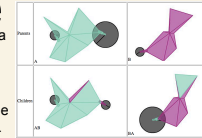
### Variation

The fuel for natural selection.  
Cars can vary in all traits.



### Inheritance

Like meiosis, parents pass down a combination of their traits.

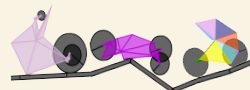


### Selection

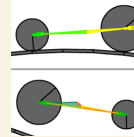
Cars that make it farthest down the track leave behind more offspring.

### Time

Generations pass and the population adapts to its environment, the track.

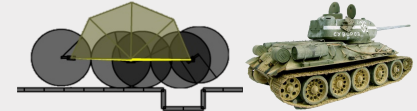


## Convergent Evolution



Students can test the famous question by Dr. Stephen J. Gould, What would happen if the tape of the history of life were rewound and replayed? By running replicate simulations on the same tracks, students can explore how traits converge on similar solutions again and again.

## Evolution and Engineering



One common argument used to challenge evolution is that random mutation could never produce traits as complex as those we see in nature. This does not account for the fact that, though mutations are random, natural selection is anything but. Using BoxCar2D, students can either allow natural selection to run on its own, to design their own vehicle, or to tweak designs produced by mutation. They are astonished to find that their best designed vehicles are often outperformed by those developed through mutation and selection over time.

## Developing Evolution Lessons using BoxCar2D

We have presented our lessons to a variety of audiences and grade levels, including middle and high school students in classrooms and workshops, elementary students at science nights, and biology teachers at the National Association of Biology Teachers Annual Meeting in 2012.



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