

# Experiencing BeeSpace: Behavioral genomics for high school and beyond

## BeeSpace Education core group

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# BeeSpace

An Environment for Analyzing Nature and Nurture in Societal Roles





# Why BeeSpace Education?

- NSF calls for projects it funds to exhibit ‘broader impacts,’ as well as ‘intellectual merit’
- The BeeSpace proposal pledged to develop educational initiatives that would contribute to middle school, high school, and undergraduate science learning



# Aspects of BeeSpace education

- Our goal: convey the substance and excitement of the project's science to young learners, through engaging and thought-provoking activities
- University: New bioinformatics course using BeeSpace at Wake Forest University
- High school: Summer course on BeeSpace biology
- Junior high school: Entomology units emphasizing BeeSpace science at Campus Middle School for Girls



# Challenges and opportunities

- Bees are little, they live in dark, crowded places ... and they sting
- Chemicals that conveniently scramble and chop up DNA in the lab can do it to people, too
- Research agendas and careers can be set back by years if lab visitors inadvertently contaminate a sample or trip over a hive box
- So the challenge: open up the educational opportunities that abound when you have leading researchers working on exciting puzzles that stretch across disciplinary frontiers ...
- In ways that are safe for the learners and sustainable for the projects



# Summer 2008 high school week

- Experiencing BeeSpace: a weeklong workshop at IGB for 14 high school students in July, 2008
- Entire curriculum is now on the BeeSpace website
- Content and organization show unique qualities of educational outreach by a leading-edge scientific research project

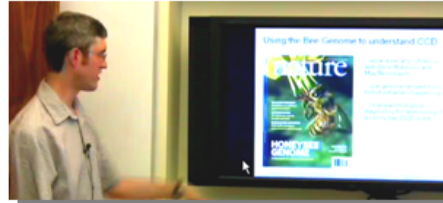


# Workshop curriculum on-line/disc



## Experiencing BeeSpace

A comprehensive video curriculum in bee biology and behavioral genomics

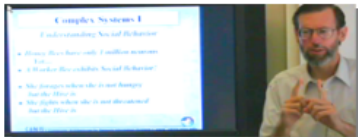


### Multimedia Lessons

- [Bee biology](#), with Dr. Susan Fahrbach (66 min.) [[about](#)]
- [Nature vs. Nurture](#), with Dr. Gene Robinson (78 min.) [[about](#)]
- [BeeSpace medical implications](#), with Dr. Bruce Schatz (30 min.) [[about](#)]
- [Colony Collapse Disorder](#), with Reed Johnson (49 min.) [[about](#)]
- [Introducing BeeSpace](#), with Nicholas Naeger (35 min.) [[about](#)]
- [Molecular biology techniques](#), with Nicholas Naeger (45 min.) [[about](#)]
- [BeeSpace behavioral genomics](#), with Nicholas Naeger (78 min.) [[about](#)]

### Lab Tours and Extras

- [Interview with bee researcher Nicholas Naeger](#) (6 min.) [[about](#)]
- [A complete BeeSpace experiment](#) (60 min.) [[about](#)]
- [Class visit to a honey bee field research facility](#) (54 min.) [[about](#)]
- [Classroom simulation of a microarray experiment](#) (20 min.) [[about](#)]
- [Tour of research equipment in a genomics lab](#) (4 min.) [[about](#)]
- [Information about the curriculum](#)
- [Experiencing BeeSpace photo galleries](#)



<http://www.beespace.uiuc.edu/elearning>



# Findings from learners

- Thesis focus: workshop learning, evidenced by interviews and observations
- High satisfaction, high engagement, claims of substantial learning
- Some learner comments from post-interview 16 weeks later:
  - “The presenters did an absolutely great job of making the information stick - at least for me. I'm still amazed at how much I remember. ... ”
  - “I actually really enjoyed what we learned during the week, and I thought it would be a great career path to follow ... because there's always more species to study, and problems will keep on arising. And we'll always want to see of those problems are traced back to the DNA or some evolution of the DNA. And so it actually influenced what I wanted to study in quite a bit, and made me think that this is something I would really enjoy doing.”
  - “I think a problem for some people was that the lectures were a little long-winded. But the problem with shortening lectures is that you don't get the information needed, that shows how you're working on this. So I don't know, but I think if it was a longer workshop instead of just a week it would be better, because you can spend more than one day on one specific thing - spend three or four days, or maybe do some experiments of our own, and see how they work out and learn how to analyze them.”



# More learner comments

- “I definitely like how you guys have all the speakers. That's always a strength for me. It's good to have hands-on, but you get a little bored after a while if it's all hands-on activities. And the same thing for just having the speakers. So I thought the BeeSpace camp had the perfect amount of that.”
- “I think your workshop was just a great mixture of actual research and, like the honeybees in the bee building - so the mixture of the hands-on and the more mental stuff. I thought that was a very good dynamic.”
- “It was actually really informative, I mean it was really cool to go out and look at hives, but I learned about all kinds of different diseases affecting honey bees, and how gene expression is worked out. I have to say that the tour of the bee lab with the giant mirrored room where they get to control they length of the day cycle just to see what happens, that was all really interesting. Now no one dares to bring up honey bees around me because they know I'll talk for half an hour!”



# Salient curricular features

- Two aspects of the curricular organization that stand out:
  - Tight sequencing of activities: from focus on the organism hands-on, to the abstract scientific concerns and complex laboratory procedures used to explore the motivating questions
  - Use of an engaging and knowledgeable research insider as a lead instructor-narrator-‘tour guide’



# Implications for science education

- Dominant approach in recent science education is strongly inquiry-oriented, particularly in ‘STEM’ research funded by NSF’s EHR directorate.
  - These are well grounded in social and cognitive theories of learning, but not always a good fit for the affordances and constraints of a project like BeeSpace or most occurring in this building
- In terms of education theory, workshop stands as a successful instance of Ausubel’s ‘meaningful receptive learning’ (1962, 2000)
- This study, while preliminary, suggests that effectiveness of MRL curricula can be enhanced by concrete-to-abstract progression and strong narrative focus
  - These claims could usefully be tested through further iterations, in a design-based research or curricular development framework



# Next steps and recommendations

- The video curriculum drawn from the 2008 workshop is being made available on disc and on the project website, and we are preparing to write about it in teaching journals.
- We invite others working on leading-edge projects to consider this as a potential model for your own educational outreach.
- We suggest that other leading-edge projects engage in research into the effectiveness of their educational outreach -- broadening impact by growing the field of science education itself.



# Thanks!

(an incomplete list)

The BeeSpace Project investigators

The Robinson Honey Bee Lab

The Institute for Genomic Biology

The National Science Foundation

Our teachers and facilitators: Susan Fahrbach,  
Reed Johnson, Katrina Lustofin, Nicholas  
Naeger, Gene Robinson, David Stone

Our learners



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