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Using Clickers to Engage Groups in Collaborative Problem Solving and Inform Cognitive Tutor Development

1. Project Motivation

Consider strengths of Clicker-Based Activities and Cognitive Tutors:

Benefits of clicker-based problem-solving activities (CBAs):

1. Cost-effective, and fairly easy to develop
2. Collaborative, hi-bandwidth discussion, range of questions, follow-up
3. Students are immediately accountable and their actions are visible to the instructor.

Benefits of cognitive tutor based activities (CTs):

1. Individualized, step-by-step assistance
2. Ease of delivery to a larger audience

How might CBAs and CTs be combined to complement each other?

2. Project Design

1. **Engage a class in complex genetic scientific problem solving.**
   - Introduce CBA leading step-by-step scientific reasoning (similar to a CT).
   - Multiple choice CBA analogous to pull-down menus in PS steps in a CT.

2. **Take a large step toward developing CT for the same material.**
   (If the activity design remains same, the main work needed to convert the CBA to a CT is the design of hint text for steps in each problem).

3. **Lay foundation for research into a novel ay to introduce problem solving.**
   as in-class CBA, to deepen subsequent student learning with a CT.

3. Clicker-Based Activities (CBAs) for Genetics

Identify Key Skills in Advanced Domains: Cancer & Developmental Genetics.
– Cancer: Mechanisms by which a Cell Escapes Normal Control
– Development: Processes by which 1 Cell becomes Functioning Organism.

Genetic Problem Solving Employs Two Types of Reasoning:

1. Process Modeling (“forward” from cause-to-effect)
   – start with underlying properties, infer observable results

2. Abductive Reasoning from Data (“backward” from effect-to-cause)
   – start with observations/data, reasons to properties leading to them (e.g., whether a mutation influencing a trait is dominant or recessive).

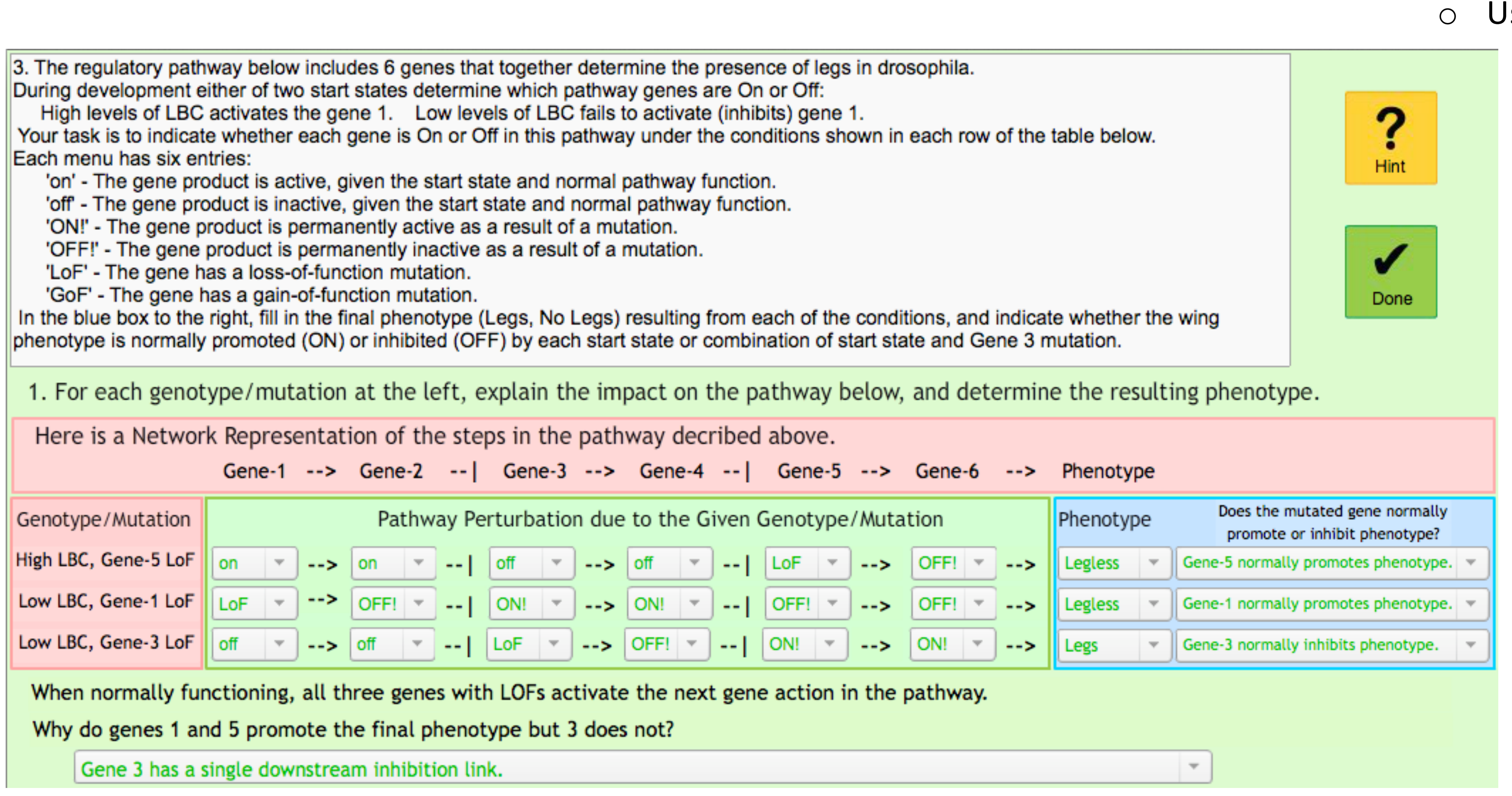
4. Project Deployment and Evaluation

Deployment:

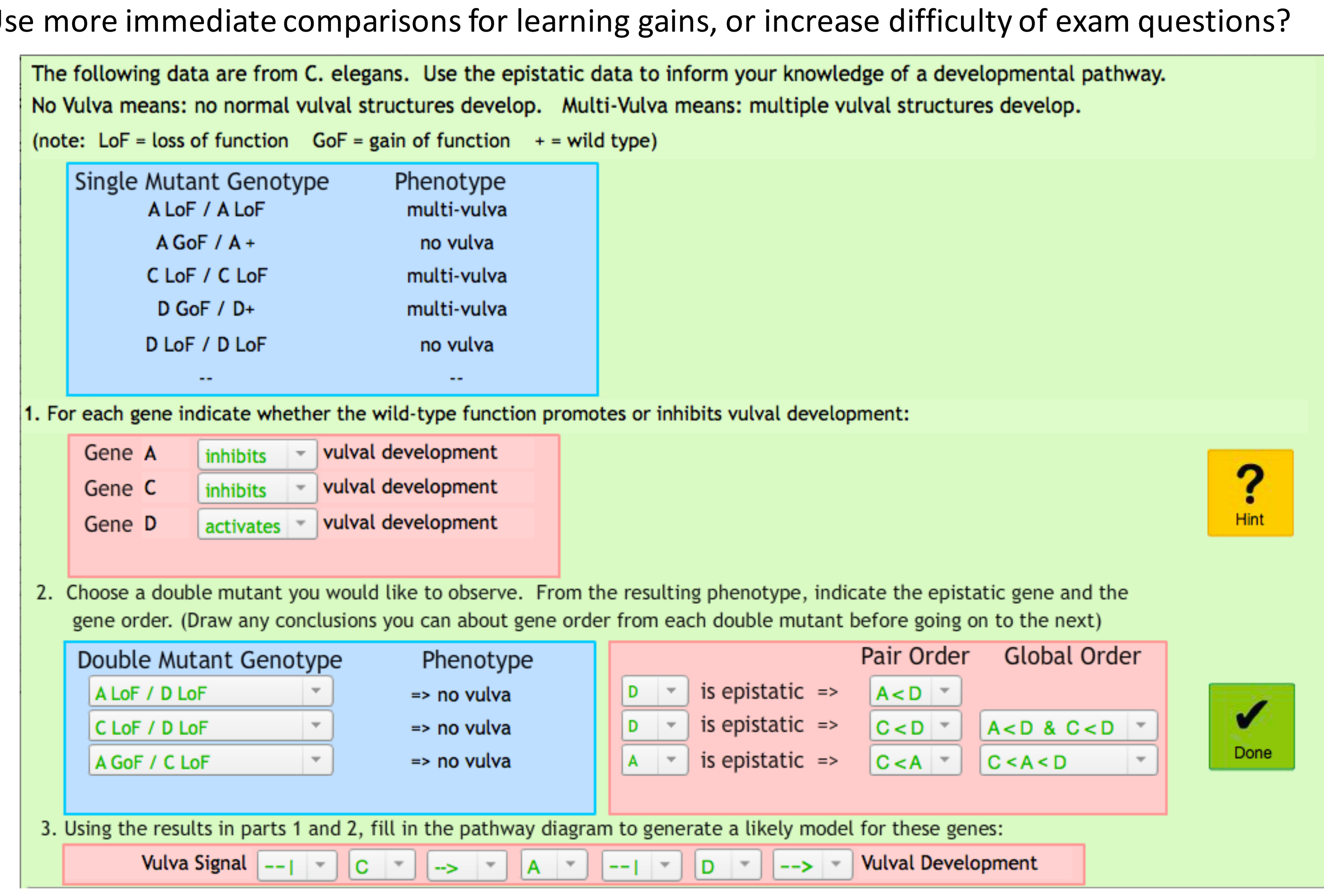
1. The instructor led a lecture and clicker-based activity (video-recorded).
2. Preceded by a pre-test of concepts &problem solving skills.
3. Following CBA, administer analogous post-test.
4. Long-term learning assessed using final exam.

Results/Lessons Learned:

1. Informed development of CT Lessons (under NSF REAL grant) (see below)
2. Students learned shallow knowledge that reduced performance on earlier problem solving (epistasis in assembly/substrate pathways, vs. new concepts introducing epistasis in signaling pathways)
3. Final Exam performance very similar to previous year:
   - Performance on both years high - Possible ceiling effects?
   - Anticipate noise in in-vivo experiments in learning interventions (3 week lag until final)
   - Use more immediate comparisons for learning gains, or increase difficulty of exam questions?



CT Lesson: Process Modeling Activity for Developmental Genetics



CT Lesson: Abductive Reasoning Activity for Developmental Genetics

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The CMU Genetics Cognitive Tutor

http://www.cs.cmu.edu/~genetics/

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