PhET Look and Feel

Underlying Ideas

There are three themes which support the PhET Look and Feel guidelines that have come from interviews. These include: the importance of engaging the students in exploration of the simulation as discussed in section V. below; the *Coherence Principle*; and *Consistency* from simulation to simulation.

***Coherence Principle*[1]**

- Adding interesting but unnecessary material to simulations can harm the learning process in several ways.
  - It can distract the user from relevant material.
  - It can disrupt the learner's processes of making sense of important information because unnecessary information is in the way.
  - It can prime inappropriate bits of knowledge.

***Consistency*[1]**

- Users' interpretation and use of simulations depends heavily on their prior experiences. If inconsistent representations or layout is used, students may spend extra time on unnecessary information or may incorrectly bring ideas from one simulation to another.

I. Layout

- Below is a basic set of layout guidelines; however, this is something, due to special characteristics of each simulation, that cannot be rigidly dictated.

A. *Control panel*

- Limiting the number of tools/controls and arranging them in small groups makes it easier to identify what is available and makes the simulation less intimidating.
- Students become familiar with the layout.
- Limited text
  - Students only read text that is attached to a control
  - Abbreviations are not understood by most students.
  - Text strings of one to three words work best.

B. *Play area*

- The play area must be distinct from the control panel in look and functionality. Objects in the play area are grabble and animated.
- When too many tools are in the play area, the control panel is overlooked.
- Text is a distraction in the play area.

C. *Backgrounds*

- Can serve as a visual cue to remind the user of the setting that they are currently exploring such as the Moon versus the Earth.
- Backgrounds should not distract the user from the important features of the simulation. Separation between the features of the simulation and the background is what is important.

D. *Tabs*

- Students notice large, cartoon-like tabs. When tabs are small and professional looking, they go unnoticed.

E. *Play buttons*

- Students do not find play/pause buttons on their own.
- Once these buttons are shown to the user, they get used as needed by the experienced users.

II. Intuitive Controls

- Interviews showed that certain types of controls are intuitive for users. If different controls are used, even with 'help' or tutoring from the interviewer, many students still cannot use the

simulation and the student's focus is on learning how to manipulate the simulation rather than on the concepts.

- Fortunately the types of controls that work for users are independent of the content of the simulation.

A. *Click and drag interface*

- Click and drag is the most natural motion for students.

B. *Grabbable objects*

- Students try to move anything that looks useful.

C. *Sliders, radio buttons, checkboxes.*

- In interviews students are familiar with the functionality of radio buttons and sliders.
- Students use the sliders when they first explore a simulation and then turn to the digital input when completing a specific task such as homework or lab.
- Students use checkboxes to turn things on but rarely use them to turn things off.

D. *Consistent set of tools*

- Students 'know' what something should look like. If it does not match their expectations, it makes it much harder for them to figure it out.

III. Representations

A. *Common picture*

- Simulations explicitly provide a visual mental model. Advanced simulations in particular corrected incorrect pictures that students had constructed from readings and lecture.
- Simulations provide a common picture for discussion. Discussion before simulation use typically starts with a fairly long conversation about what the phenomena looks like before students can begin discussing the concept – with simulations, this part is unnecessary and students are more confident about what they are discussing.

B. *Start up settings*

- To encourage exploration, simulations should start up with very little or no animation.
- Using only a "wiggle-me", that comes in and stops, is an effective way to initiate desired exploration.

C. *Real world connections*

- Simulations showing familiar everyday objects encourage exploration and encourage understanding.
- Cartoon-like features are an effective way to emphasize important features while avoiding misleading literal interpretations.
- Students test the limits of the simulations looking for realistic reactions. Simulations need to 'break' in a meaningful way when pushed to extremes. However, care must be taken that the 'breaking' is not too exciting or it can easily become the focus of the simulation.

D. Visual cues – everything matters.

- Students look at all visual cues equally, if they do not understand a concept. It is important to emphasize items that are pedagogically important and eliminate all potential distractions.
- Color is an important visual cue. Students expect it to be consistent not only within a particular simulation but from one simulation to another.

E. *Consistent representations*

- When an object is represented differently from simulation to simulation, students perceive it as two different objects, and when objects are represented in a similar fashion they are perceived as the same, even though they may be completely unrelated.

IV. Help

- In a good simulation, help is not necessary to stimulate learning.
- Too many words of help can be a deterrent to learning.

A. *Wiggle- me*

- When the most important object in the play area is not obviously grabbable, a wiggle-me is useful for telling the user where to start.
- Consists of a very short, clearly written directive (eg. Wiggle the electron) with an optional arrow pointing toward the object it refers to.
- The wiggle-me should draw attention to itself; however, it should not distract the user from the rest of the simulation.
    - It should swoop in from the side and then remain stationary until the object it is referring to has been manipulated.

B. ***Help!***

- Must be clear, concise strings of text.
- If it's prominent, then it gets followed like a command and the user is unlikely to explore on their own.
- Help! should not appear unless it is requested by the user.
- Once invoked it needs to remain on screen as continual reference while the user plays. For this reason it must sit somewhere that it can stay up and not be in the way while manipulating the simulation.

C. ***Extensive help***

- Users do not use extensive help

V. Encourage Exploration

A. ***Animation and interactivity***

- Students notice animated features first; however, students do not ask questions and make new connections when only observing and not interacting.
- User control of every perceived potentially significant parameter is valuable.
- Limiting students control over certain items must be done carefully.

B. ***Little puzzles/clues (Questions that stimulate student to figure things out)***

- When students encounter small features that they do not understand, they will explore how the feature changes the simulation until they can create a working definition of the feature.
- Legends and control labels tell the student what a particular feature controls and then when they play, they learn a working definition of the control..
- Multiple Representations - Simulations that have multiple views of the same idea such as beam view and photon view facilitate further understanding and connections about the idea.
- Exploration is not always productive – Features which encourage exploration in unproductive directions must be avoided.

C. ***Fun***

- When the simulations are fun, students enjoy playing with them. The Flash simulations and JAVA simulations, with similar characteristics, draw students to them.
- When simulations look boring or intimidating, students are not drawn to playing or they're afraid they'll break them.
- Danger of being so much fun students may be distracted from learning.

D. Credibility of simulations

- For engaged exploration to occur, students must believe the simulation.
- Student's level of skepticism is directly related to their level in school.

E. Performance mode

- Students who do not think they know the relevant ideas will comfortably explore a simulation and will try to use it to learn; however, students who think they should understand the topic of a simulation use it much less effectively and learn much less from it.

[1]. Clark, C. and Mayer, R. (2003) *E-learning and the Science of Instruction* Pfeiffer; San Francisco, California. Pgs 111-129.