Software Evaluation Of Thinker Tools, JavaGami, and Belvedere

1. Situated Learning / Thinker Tools

The Thinker Tools create a virtual physics lab for students to design and run experiments. Physical phenomena and principles involved in this software are: force, motion, acceleration (gravity), friction, and a variety of object characters (mass, elasticity, fragility, etc.) As we tried this software in class, we first saw a blank window where we would design our experiment. Then we chose objects from the menu to add them to the main window, such as a ball or a floor. We then adjusted the characters of the objects we put in (mass, etc.) and the character of the environment (gravity, air friction, etc.). These options were also available in the main menu. Finally we clicked “Start” and observed what happened to these objects.

The theory that supports ThinkerTools is situated learning (e.g., Lave, 1988; Lave & Wenger, 1991; Greeno, Smith, Moore, 1992), which emphasizes that knowledge is specific to the situation it is learned from. The most natural way to acquire knowledge in a domain is to get involved into this domain and practice it. ThinkerTools is one of the various simulation applications in classroom. It contextualizes physical principles and enables students learn physics in a simulated “real” environment with empirical evidence. It is much easier for students to observe how abstract physical principles affect these “real” objects and understand the principles, than simply learn it in an abstract form. During a physical experiment, students manage their own process and

teachers are playing a role as facilitators who provide scaffolding and instructions on generating a research problem, setting up experiment conditions, observing the outcome, and making abstraction out of real world contexts. Not only do students benefit from a better understanding of physics itself, but they also acquire metacognitive skills as well.

As I tried ThinkerTools, I found its advantages are: 1. It can simulate many physical conditions and phenomena which a real physics lab cannot make. For instance, some kinds of experiments need extreme or ideal conditions (zero gravity, or zero air friction) which are not realistic in real environments. However, computer simulations like ThinkerTools can provide this condition. 2. A real physical experiment usually comes up with unexpected consequences, some may be dangerous, while a simulated one avoids that. 3. It's more cost and time efficient that a real physics lab. "The aim of using simulation is to recreate or represent in a limited time in the classroom particular situations which exist in the world outside." (Reynolds, M. 1994).

The disadvantages of this software are: 1. It is not perfectly programmed. Some bugs show violations to physics principles. (I'd rather call it bug rather than disadvantage.) For instance, by adjusting the gravity and elasticity of a ball and the floor, we may see a strange thing happen: The ball drops and bounces to a higher position than its original height. After several bounces, the ball simply jumps out of the screen! We all know that this can never happen. Now matter how I adjust the characters of any objects in the experiment, it is impossible that energy can be

generated from nothing. 2. There are many options in the menu by which students may set the environment and characters of objects. Not all of the settings make sense to students with lack of prerequisite knowledge. It is common that a student doesn’t understand a setting and then ignores or mistakenly sets the experiment, which will easily lead to a wrong outcome. 3. The ThinkerTools shows a force affects the motion of an object, but doesn’t show how much the effect is. In other words, it shows a relationship between certain forces and motions, but not at a quantitative level. It does not benefit students in using physical formulae and calculating the answer.

2. Constructionism / JavaGami

Constructionism derives itself from constructivism. Two major schools of constructivism are Piaget and Vygotsky. Piaget postulates that each individual makes contribution to the development of the society. On the opposite, Vygotsky stresses that social development promotes individual development. People learn from interacting with experts or those peers with higher achievements and being scaffold in their Zone of Proximal Development . Although these 2 schools have different views on the relationship between individual and society and how people interact, they do share some basic tenets in common, such as learners construct their own understandings from their own experiences in doing authentic tasks.

Constructionism -- the N word as opposed to the V word -- shares constructivism's connotation of learning as 'building knowledge structures' irrespective of the circumstances of the learning. However, as Papert described, it is

grounded in the ideas that people learn by actively constructing new knowledge, rather than having information poured into their heads. People learn with particular effectiveness when they are engaged in building a “personally meaningful” project. Another key point of constructionism is the public representation of this project. Constructionism adds the idea that building of knowledge happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe. (Papert, S. 1991) The key words are “actively”, “meaningful”, and “public artifact” in the definition of constructionism, as compared with constructivism.

One of the features of the JavaGami follows the ideas of constructionism. It has the ability to tweak any of the elements of a paper sculpture (i.e. shape, color, etc.), and be able to see the immediate result on screen and the real artifact in the real world. Based on certain categories of basic geometric shapes, this software gives the learner a lot of freedom, as in what type of shape or pattern they want to take. After a paper sculpture is generated, students may modify the shape (i.e. cutting) as well as changing a surface color or pattern. This allows the student to build any type of sculpture they want, allowing failure, and leaving plenty of room for improvement using various different techniques. After experimenting with the JavaGami for a while to obtain the desired sculpture, the learner will gain the experience necessary to learn further topics in geometry. Another important element of constructionism in is the opportunity for the student to show off what they have built. This is also included in the JavaGami. The learner prints his/her artifact from computer screen and glues up a

very meaningful artifact to be viewed by the instructor as well as the student's peers. Such artifacts also act as advertisements for the fascination of the domain itself. (Pedersen, J. 1988)

Some minor disadvantages I found in JavaGami are: 1. A new user may find the menus and buttons confusing. Sometimes a button disappears mystically and I have to click where I figure the button should be. 2. I can only modify all predefined shapes, I cannot create and integrate my own shape from scratch.

3. Computer Supported Collaborative Learning / Belvedere

Collaborative learning is a pedagogy in which students with different achievements work in groups in order to achieve a common goal. Both Piaget's and Vygotsky's theories are constant in emphasizing that collaborative learning is important. Piaget (Piaget, J. 1928) postulated that collaborative learning has a major role in constructive cognitive development. Collaborative learners learn from resolution of conflicts. Interaction between peers is equally shared. However, Vygotsky (Vygotsky, L. S. 1978) stresses that social interaction is the core of developmental process and that social interaction is asymmetrical, which means those with low level of ability learn from interaction with those with higher ability (i.e. adult-child, teacher-student, etc.). Diversity of knowledge and ability in a collaborative group facilitates this kind of interaction. From this group interaction, collaborative learners construct a socially accepted understanding of knowledge, negotiate on alternatives, and internalize the finalized knowledge. In a collaborative group, students learn from interaction with

peers within the group, while teachers act as a resource to support students' learning from their own. Collaborative learning also significantly improves problem solving strategies (Bruner, J. 1986) and critical thinking skills. A collaborative environment provides students with an opportunity to confront with different interpretation of the situation and different problem solving strategies, engage in discussion with peers, and develop critiquing and self-critiquing skills. Naomi Miyake (Miyake, N. 1986) confirms that in the learning process the bulk of Constructive Criticisms occur while learning in collaboration. The experiment showed that about 80% of self-critiquing (reflection) took place during collaborative learning compared to 20% which took place when students were learning alone. Self-critiquing is one of the major contributors to the effectiveness of collaborative learning.

Belvedere is a Computer Supported Collaborative Learning software providing synchronous interaction for learners. Long distance collaboration may also be integrated as its function (if networking enabled.) As Daniel D. Suthers, the designer of this software, described, Belvedere helps students develop critical inquiry skill through this knowledge mapping software. (http://lilt.ics.hawaii.edu/lilt) By trial using this software, I found the advantages of it are: 1. It externalizes students' abstract ideas in their minds to the overt computer screen, which makes it easier for group members to share and exchange ideas and keep track of the work, as well as for teachers to take control of students' thoughts. 2. It stores and manages all information that students input, and allows students to access all information quickly and directly without any loss and hence facilitates students to build new knowledge on this

repository. 3. By using this software, students have more freedom in thinking and responding to others' ideas rather than being pressured to say something in a traditional oral discussion. 4. It helps students identify the structure of hypotheses, data, evidence, counterevidence, conclusion, etc., and relations among them, and then reflect on their own ideas after a "what you see is what I see" collaboration within the group. This helps students improve their reflective inquiry skills, which will be beneficial to their future academic research. I also came up with some minor disadvantages in this trial version Belvedere: 1. The "update (hypotheses, evidence, etc.)" function didn't work. 2. It may take some time for students to get familiar with the interface before they can collaborate without difficulties. 3. I think the trial version (single user, no networking) is not better than a paper sheet and a pen.

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