

Teaching Critical Thinking and Problem Solving Skills Through Online Puzzles and Games

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Abstract: - In this paper, a new way of teaching critical thinking and problem solving skills is presented. WebCT Vista – one of the most popular online education tools – is used as the essential platform. Instead of being taught as abstract concepts, problem-solving techniques like logical deductions, generalizations, and analytical reasoning, etc, are delivered to the students via mind-bending puzzles and games. Course materials are very carefully selected such that each of them is real-life centered and produces a deeper understanding of content while offering weapons to tackle with additional situations. All these features collectively make the course unique, efficient, and successful, based on the student feedbacks.

Key-Words: - Games, Puzzles, WebCT Vista, Critical Thinking, Problem Solving

1 Introduction

Critical thinking and problem solving skills are among the essential skills that every college student needs to develop and nurture in order to survive in such an information explosion era, where the present Sunday edition of the *New York Times* contains more information than the average person living in the 1800s would encounter in a lifetime [4]. Such skills are loosely defined as the capabilities of predicting, making accurate observations, generalizing, comparing and contrasting, uncovering assumptions, understanding connections, reasoning through analogies, and finding causes. Typically, they are taught in one or more elective courses that are offered to the general student body, regardless of his or her major. In this sense, Valdosta State University (VSU) is not an exception.

However, in this paper, we present a *new* way to teach critical thinking techniques that we started to adopt since the summer of 2007 with the class number: PERS 2720. It was online, puzzle and game based, and real-life relevant. Students were evidently more attracted and motivated, as they were willing to make more effort to pursue the optimal solutions to the questions in assignments and showed their creativities to explore alternative approaches. In the following, we start to discuss the benefits of using WebCT Vista as the teaching vehicle. Then, the next section will focus on the puzzles and games selected for this course, along with the students' reactions and feedbacks. Such

puzzles and games were very carefully picked and categorized such that each covered at least one area of critical thinking as described above. We will conclude the paper with conclusions and future works.

2 WebCT Vista

WebCT Vista is a leading provider of e-Learning solutions for higher education. It provides a state-of-the-art teaching and learning environment that streamlines course management for faculty, offers capabilities to help improve student outcomes, and creates powerful efficiencies institution-wide. Although it has been used in many courses at VSU, it was the first time for PERS 2720.

2.1 Why Teach Critical Thinking Online?

First of all, it is the nature of the subjects covered in this course that makes it a perfect fit for an online course. Our goal here is to train and arm the students who are looking for a creative experience with tips and strategies helpful in any other class or real-world situation. The virtual classroom built upon WebCT Vista makes such an inherently *time* and *labor consuming* training process easy and enjoyable to the students, many of whom have to work during the day time.

Secondly, WebCT has proven to be a successful Internet-based education tool over the years. Course materials are accessible to the students no matter

where they are (actually, many students finished one of the assignments while they were enjoying the 4th of July holiday), information sharing is made very easy to the students, user interface is sufficiently clear and intuitive, and technical support is there constantly whenever a problem pops up. See the home page of this course in figure 1.

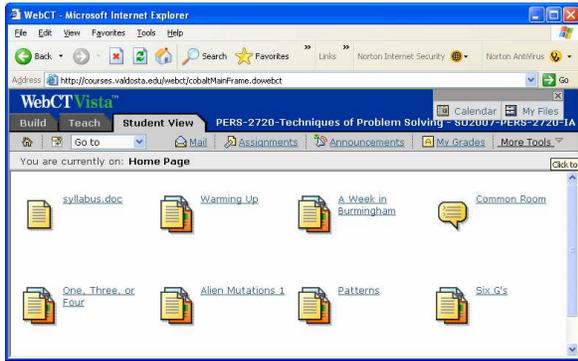


Figure 1 Home page of the Course

2.2 “Real-world” Problems

One of the biggest differences between traditional classroom type of classes and online classes is that from time to time, students need to learn to tackle with “real-world” problems like getting familiar with the WebCT Vista environment; making sure software running on the machines they have at home/work are properly configured to match the requirement of the class; interacting with the instructor and other classmates via the Internet, etc. Remember, most students are not majored in computer science or information technology. To them, such an experience might be a little bit frustrating, but at the same time, very invaluable too since they are here to learn *problem solving*, aren't they!

Here comes a real story. In playing the *Silversphere* game (a brain-challenging game I will describe later), a requested update for JavaScript was allowed in order to enter passwords to start at different levels, rather than having to play through the game in successive levels. The updated JavaScript version installed on one of the student's machine upon “allowing the update” resulted in a conflict of application software versions, which, unbeknownst to him at that time, prevented the functionality of WebCT Vista on his home PC. With the assistance of VSU's IT Helpdesk and the VSU IT department's web page, and several HOURS of distressful, perplexing labor, he once again was able to access and use WebCT Vista in the comfort of his own home.

3 A Fun and Challenging Experience with Puzzles and Games

I chose to use real-life relevant paper-based and/or computer-based puzzles and games as an arena to practice critical thinking and problem solving skills and here is why – I believe content is essential to teaching critical thinking skills. By utilizing real-life situations, students may then appreciate the value of these skills in the analysis of facts. This combination forms an intricate network of connections that produce a deeper understanding of contents while offering a thinking platform from which to analyze additional situations.

During the process of preparing and teaching this course, I kept reminding myself that the ultimate goal of having fun with puzzles and games was to grasp skills of critical thinking that could be applied to solve future problems in broader context [4].

Of the puzzles in this class, most required no special knowledge and could be done with a piece of paper and a pencil or pen. A very limited number of puzzles, however, called for some knowledge of simple high-school algebra. If such instruction had been lacking or that knowledge had become a bit rusty over the years, these puzzles could be considered a pleasurable introduction to algebra or a refresher course.

3.1 Learn by Solving Mind-Bending Puzzles

In this section, I pick a number of puzzles [1, 6] that I assigned students to solve to demonstrate how the class was organized. Typical student feedbacks are enclosed within quotation marks.

In the first assignment, I kind of gave students a warm-up of the class. By figuring out how many different paths to go from one brain cell to another (see Figure 2 for one of them) as part of the assignment, they got a first-hand idea of the fact that no matter how hard or simple a problem is, there are almost always numerous courses or routes that may be taken or omitted to arrive at a solution. “*Developing an organized and ordered system of solution is important so as not to duplicate or omit a path*”.

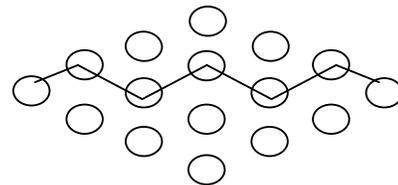


Figure 2 The Brain Net

“A week in Cantonville” exercised one’s skills of patterns and deductions. To figure out store operation hours in a town called Cantonville given a list of restrictions, one had to deduce that there were certain days when all or some of the stores were closed or open. He had the information, and then he needed to fill in the blanks, using a chart or whatever other reasoning tool you needed to utilize. “The Cantonville store was a realistic example—it was something that could happen in any small town across America, so it was simple to visualize and make connections. I learned to consider everything carefully and then to check it to make sure it makes sense and fits with the statements you began with.”, one of the students said.

Then there was a game about coins and two players taking turns drawing coins from a stack. The object was to determine a winner or a loser. Each player could only draw a certain number of coins like 1, 2 or 4 on alternate turns in order for it to be fair. Some students tackled with this puzzle in a formal way (as the learning material I provided them along with the puzzle itself suggested). Such an approach required analysis of every conceivable combination of moves in the game with a finite number of possible moves or positions. Mathematical relationships and possibilities must all be evaluated to meet a specified “winning” outcome. *Each possibility* was defined as either a winning or a losing position as each player alternated drawing either one, two or four coins from a pile of ten. What they ended up with was a series of logic steps like below:

- a) *Drawing from one coin, a player loses.*
- b) *Drawing from two coins, a player always has a sure winning position by removing one coin from the pile.*
- c) *Drawing from three coins, a player always has a sure winning position by removing two coins from the pile.*
- d) *Drawing from four coins is a losing position. If one coin is removed, the opponent is left with a winning position of drawing from a pile of three(c). If two coins are removed, the opponent is left to draw from a winning position of two (b). If all four coins are removed, the player has drawn the last coin and thus loses.*
- e) ...
- f) ...

Others found it rather easier to put themselves in the position as if they were really playing the game. They actually tried playing the game with their friends or parents in order to figure out the answer. This was actually the way I preferred since while

playing the game, they implicitly exercised the capabilities of predicting, making accurate observations, comparing and contrasting, and understanding connections.

Pattern recognition and generalization are an extremely useful aspect in critical thinking. For that, I used two puzzles to emphasize its importance.

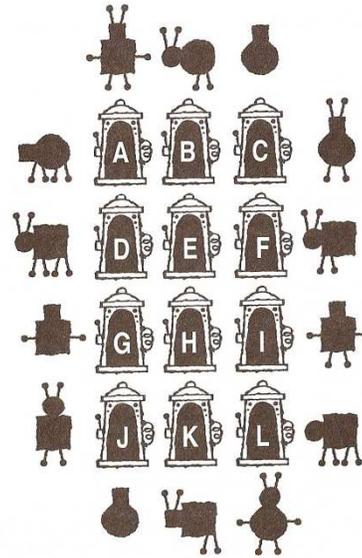


Figure 3 The Alien Mutation

As shown in Figure 3 above, the goal was to determine the functionalities of each chamber from A through L to accomplish the alien mutations. Students had to consider the mutation chambers across and vertical. “I felt that some chambers did nothing, and that was obviously a big mistake on my part ... I have since went back and tried to work the problem, and I now see the patterns. The Alien Mutation exercise definitely relies on the power of patterns and the ability to compare and contrast.” – one student said. A more visualized puzzle was to uncover geometric arrangements with a defined repeatability in the “What’s Next” problem (Figure 4). Surprisingly and interestingly, most students solved this puzzle successfully. I guess “Pictures helped”.

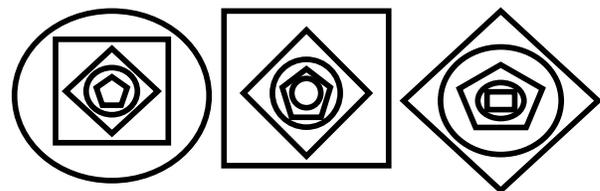


Figure 4 What’s Next?

There were some other puzzles where students found trial-and-error to be the most efficient approach (I don't bother to put the details here in this paper). All in all, every assignment proved that difficult and seemingly impossible puzzles have a systematic method of construction which can be deciphered flawlessly. Even not so difficult puzzles contain elements of analytical value.

3.2 "Warning: The Silversphere Game Could Be Addictive!"

To most students, the *Silversphere* game [7] was probably the favorite part of the class. It is entertaining, sometimes even addictive (the title of this subsection is what I quote from one of my student's comments). It is downloadable for free via <http://www.miniclip.com> and easy to use – anyone can launch it with any Web browser that supports flash files. More importantly, it teaches students various critical thinking skills, among which *accurate comprehension of instructions*, *time management* and *keeping persistent* being the most useful ones.

To give you an idea how the game looks like, I screen-captured a couple of snapshots and listed them below in Figures 5 and 6.



Figure 5 The Silversphere Game, Level 3

The goal of the game is to move the silversphere to enter the blue vortex before the clock elapses. You have to stay clear from the water and avoid from running into anything for the silversphere will explode. As you progress through different levels (students are assigned one level each week), difficulty builds up too. For instance you might need to push boxes and/or slide ice cubes around to clear paths, build bridges, and locate the target vortex that is initially hidden (figure 6).



Figure 6 The Silversphere Game, Level 13

The silverspear game starts with very basic reasoning concepts and advances by levels of difficulty according to the number of successive levels attained. One must first read and understand the instructions given at the start screen that introduces the game. A total understanding is not actually achieved until you play the game and *learn from experience*. It is then that the instructions may be fully realized.

The time clock is an important element of the game. Oftentimes the clock would expire before the solution was reached. This gives students a clear idea how important time management is. In real life, deadlines must be met. Dealing with stressors in real life is an important concept. Meeting goals ahead of schedule gives a sense of satisfaction and accomplishment.

Simple expedient solutions are not always evident or obvious while the most obvious way is not always the best way. Defeat should serve to challenge, not invoke surrender, which is another important concept in solving problems in life. In other words, *persistence* pays off. If at first you don't succeed, try again. Do not be intimidated by the seeming complexity of a problem. Things are not always as they seem, one huge problem may only be a series of small individual problems that can be solved easily, one by one. The number of attempts and failures will be minimized by reading, understanding, and following the instructions.

4 Conclusion

Both teaching and learning critical learning and problem solving skills through online puzzles and games via WebCT vista are such a pleasurable experience. Yet there are issues that I would like to

address in the subsequent classes: Besides assignments, chat room, grade book, mail, etc, that are currently being used, I am going to exploit the features offered by WebCT Vista to a broader extent, for instance, live classroom, voice board, etc. I also plan to offer students with more games that they could play online in *groups* and stimulate their interests via competitions since communication skills and the spirit of team-work are so important in problem solving that they cannot afford to miss.

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