Folklore-based Learning on the Web---Pedagogy, Case Study and Evaluation

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Abstract

Folklore-based learning is a kind of situated learning paradigm in which students learn by solving problems embedded in a near-real situation. The proposed learning approach employs further interesting story plots from folklores as the background situation to motivate students to participate in learning activities. It is believed that such a paradigm has, on one hand, the advantages of helping students to learn in an authentic situation and, on the other, the provision of interesting story episodes as a stimulating agent for less initiated students.

This paper reports a folklore-based learning system based on the well-known Chinese folklore called "Tong Pak Fu and Chou Heung," and its effects on learning the subject of probability by a group of 454 Hong Kong secondary school students when compared with 3 teacher-guided methods. Results show that although no significant differences can be found among the different methods initially, when students with high pre-test scores were excluded, the folklore-based learning group outperformed the other groups. Also, from student perception of the system, it was found that the students prefer using this system to learn. Consider that no guidance on the subject matters was given to the students learning through this system, while students using the other methods were guided by experienced teachers, the results are very encouraging so that improvement and future developments to cover more topics are warranted.

Folklore-based Learning on the Web -- Pedagogy, Case Study and Evaluation

The Web brings great impact to the modern society. With its large repertoire of information, and anytime and anywhere availability, the Web is believed to be a useful tool in enhancing teaching and learning. Some educators (for example, Parker, 1997) argue that Web-based learning will eventually lead to a paradigm shift of learning style, from teacher-centered to student-centered. The traditional role of teachers as knowledge providers will be changed to that of learning facilitators, since students can learn from the wide repertoire of information enabled by the Internet. Researchers and policy makers (see, for example, Hong Kong Education and Manpower Bureau, 1998) suggest that teachers should play the role of helping students develop high-order abilities such as problem-solving and creativity rather than just delivering factual knowledge like what it used to be. Students are expected to learn through communicating, either in a real environment requiring personal contact or on the Web, and then construct and reorganize their own knowledge. As suggested by Parker (1999), "The result of interactive learning can be new knowledge, reorganized knowledge, or simply the awareness of a need for additional understanding." The result of such an interactive learning process will "lead to internalized, long-term understanding" (Kiesler & McGuire, 1987).

However, to change from a teacher-centered learning style to a student-centered one, students' active participation is needed. Without such, they would not access the large repertoire of information even if it is conveniently available (Owston, 1997).

A vital ingredient of future Web-based learning is therefore research on how to motivate students. The proponents of situated learning argue that learning as it normally occurs is a function of the activity, context and culture in which it occurs (i.e., it is situated) (Lave, 1988).

The use of the Web to promote learning should therefore be done by providing a near-real situation for students to experience and then learn the related skills. However, real situations may be too complex and sometimes boring, at least, to some students. Other researchers (e.g., Learning Technology Centre, Retrieved February 23, 2005) reported that discussions among mentors and mentees can be much more fruitful when they can be anchored around a specific context such as a "Jasper" adventure (Learning Technology Centre, 2005). Such kind of anchored learning gained a lot of success in the United States, but was not so when it was moved to the East (Shyu, 2000; Lee, 2000). Measures have to be taken to arouse students' interest in participating in Web-based learning.

We propose folklore-based learning, in which learners are situated in a problem-solving context designed using a folklore story plot. A Web-based online version of the learning system on the topic of probability was developed based on this principle. An important aim of our study is to investigate whether learners would be motivated in their problem-solving task using a story plot based on familiar folklores. We would also like to study the effect of teacher guidance using this approach. Since our method is a form of problem-based learning, we compare our learning system against three other teaching approaches all with teacher guidance: conventional lecturing, problem-based learning, and problem-based learning with story plot. Care was taken in the experiment to ensure consistency in the learning materials and to avoid the teacher effect. Results confirm that approaches with a story background are superior to the others in terms of learning effect and are well-liked by learners. Between the Web-based version and the teacher guided version of folklore-based learning, we found no significant difference. We believe that the teacherless Web-based version has immense potential as a future online learning tool.

The rest of the paper is organized as follows. The concept of folklore-based learning will be introduced first and then followed by a description of the learning system. In the last part, results of evaluating the effectiveness of the learning system are reported and discussed, before concluding remarks are given.

The Folklore-Based Learning Paradigm

To address the motivation problems of current Web-based learning paradigm, we propose to embed learning activities in an interactive adventure highlighted by problem-solving tasks situated in a folklore-based story plot. Modern computer technologies allow us to package the concepts in a multimedia environment. To test the feasibility and effectiveness of our proposal, we constructed a prototype system on the subject of probability based on the famous Chinese folklore "Tong Pak Fu and Chou Heung Love Story."

Tong Pak Fu was a legendary poet, scholar, painter artist, and womanizer of his time in the Ming Dynasty. His work is praised by all and still remains a crucial part of Chinese fine art and literature. His tales have provided inspiration for numerous Chinese folklores, the most well-known of which is the Tong Pak Fu and Chou Heung love story. Rumored to have eight wives, Tong Pak Fu could not resist the electrified pulse induced by the first sight of Chou Heung in the busy market square. After his unsuccessful flirting attempt with Chou in the temple, Tong paved his way to work as a manservant in the Wah Mansion where Chou was a maid. Although Tong managed to win the heart of Chou eventually, Mrs. Wah decided to give Tong the ultimate test, in which Tong had to pick Chou Heung from a group of brides with their faces masked.

In the developed learning environment, students are presented problems from sample space construction to simple probability and to conditional probability, and eventually the well-

known "Monty Hall Problem" (Fowler, 1996; Morgan et al., 1991) as an ultimate test of the students' understanding of the subject matters. While the folklore serves to arouse students' interest, the learning activities are basically in the form of problems-solving embedded in the situation. The paradigm is thus a kind of situated learning but with the folklore as the added interest elements to motivate the students. Our prototype learning system can be accessed at: http://www.cse.cuhk.edu.hk/~mhp/. This famous folklore appeared in books and movies. It is believed that students will be motivated to solve the problems embedded in the story by playing the role of Tong Pak Fu and going through a similar love chase for Chou Heung, except that the challenges faced by Tong are all in the context of probability.

The Learning System

The story is rewritten and divided into 5 scenes representing the different stages of the courtship of Tong Pak Fu towards Chou Heung. Each scene contains one problem for students to solve in order to understand a particular concept. Each such problem is also divided into several smaller problems which are expected to be solved by the students independently, or with the help of a wise old man genie ("Genie" hereafter). By playing the role of Tong Pak Fu ("Tong" hereafter) to win the love of lady Chou Heung ("Chou" hereafter), students have to experience the different scenes and tackle the problems in those predefined contexts. The folklore-based learning environment is therefore *a role-playing problem-based learning paradigm with students motivated by fantasies*. In the following, we detail the curriculum design based on each scene, followed by an exposition of the various learning techniques deployed in the framework and system.

The First Sight

This scene took place in the market place, where Tong's good friend Chok Chi Shan ("Chok" hereafter) lost money to a street gambler. Chok summoned Tong for help to analyze the betting strategy of a modified Chinese dice game. The purpose of this simple module is for students to experience and to learn the concept of "sample spaces," "events," "frequency and simple probability," "outcomes with equal probabilities," and the "sum rule." Techniques employed to stimulate students' analytic and observation skills include multiple-choices and fill-in-the-blanks (see Figure 1) for guided discovery, and real-time simulation and verification of concepts (see Figure 2). The Genie also appeared for the first time to explain difficult concepts.

—Insert Figure 1 here—

—Insert Figure 2 here—

With all the statistical knowledge in belt, Tong helped Chok to win back all his lost money from the street gambler. At the end of the scene, Chou also walked by the street gambling stall, where Tong saw her for the very first time.

The Temple Encounter

After seeing Chou at the market place, Tong fell madly in love with her. In return for Tong's favor at the gambling table, Chok advised Tong of Chou's habit to visit the temple on the 15th of every month to pray for her future. Tong immediately saw it as a great opportunity to get to know Chou by disguising as a fortune-teller. When challenged by Chou of his fortune-telling skills, Tong resorted to boost about his ability toto predict the outcomes of the ancient Chinese divination tool called the Holy Cups, before he regretted for such a bold claim. Fortunately, the Genie came to the rescue again, guiding Tong to uncover the probabilistic nature of the Holy Cups. Students learn the "product rule" from simulation, the construction of "tree diagrams",

fill-in-the-blanks, and multiple-choices (see Figure 3). This module also demonstrates a case of abuse of the use of probability by Tong, in which he used probability to bet on the outcome of a single try. Probability should be considered a measure of the chance of a particular outcome in a large number of trials. This is pointed out by the Genie at the end of the scene. Regardless, Tong left a good impression with Chou.

—Insert Figure 3 here—

Taming Brothers Two

The temple encounter was truly encouraging. Having interacted with Chou once, Tong wanted to see her everyday. He decided to pave his way into Wah's House, where Chou worked as a maid. While Tong was hoping to be the butler of the House, to his very dismay, he was assigned only to take care of the studying needs of Wah's two boys. Worse yet, Tong was not allowed to go beyond the study lounge and never got a chance to see Chou. Knowing that Tong wanted to see Chou, the two boys challenged Tong to another Chinese dice game involving two dice in exchange for the possibility of skipping Tong's boring lessons. If Tong won, however, they would have to take him to see Chou. The learning system guides Tong (the students) to carefully analyze the game using the techniques learned in the previous modules, and to come up with a winning strategy, but Tong still lost. Puzzled, Tong asked the Genie for help. It turned out that the two kids used crooked dice to cheat on Tong: one dice has only faces with 4, 5, and 6m,, and the other only with 2, 5, and 6 (see Figure 4). The Genie blessed the second dice with magic so that it would always result in an upturn of 2 when thrown. In studying the new situation, Tong (the students) got the first taste of "outcomes with unequal chances" and "simple conditional probability." With high probability, in the real-time simulation, Tong was able to use the blessed crooked die to beat the two kids in the dice game, and was taken to see Chou.

—Insert Figure 4 here—

House of Wealth

Seasons came and seasons went, but Tong's love for Chou could never end. Chou was shy and her face flushed red. Their hearts were already tied together in one pack. Thinking that Tong was merely a playboy, Mrs. Wah disliked Tong very much, despite the many small talents that he had exhibited. She decided to give him yet another test, in which three boxes with two gold coins, two silver coins, and one gold and one silver coins respectively would be placed in random order, and one box would be picked randomly. Tong's job was to tell what coins are in the chosen box. This is random guessing at best, and, of course, the Genie came to the rescue as expected with a pair of X-ray spectacles. The tragic nature of the story governs that Tong dropped the spectacles by accident, impairing the full functionality of the magical device. Instead of seeing through the boxes, the broken spectacles allowed Tong to see only one of the coins in the boxes. This is where tree diagrams and conditional probability come into play (see Figure 5) in the analysis of the new situation. The conclusion is that if one sees a gold coin using the broken magical spectacles, there is higher chance for the box to contain two gold coins; similarly if one sees a silver coin. Using this trick, Tong had no problem in winning in the real-time simulation of the game, and he was allowed to date Chou.

—Insert Figure 5 here—

To Switch Or Not To Switch

Love is many a splendid thing. Tong could hold no longer and proposed marrying Chou to Mrs. Wah. Surprisingly, Mrs. Wah gave a green signal right away. On the wedding day, however, Mrs. Wah broke her promise, and demanded Tong to pass the ultimate test. Failing to do so, Tong could never enter the Wah's Mansion for the rest of his life. The final challenge is

as follows. Four ladies, including Chou, in exactly the same bridal dress came out with their faces masked. Tong would pick one of the ladies among the four. Mrs. Wah would then uncover the masks of two out of the three ladies not chosen by Tong, and these two would always *not* be Chou. So, two masked ladies remained: one picked by Tong initially. Tong would then be given a chance to decide whether to change his choice, and this choice is final (see Figure 6). What is just described is actually a slight generalization of the well-known Monty Hall Problem (Fowler, 1996; Morgan et al., 1991). To be able to tackle this difficult problem, students would have to exercise and apply all the learned concepts, from sample space to tree diagrams to conditional probability, in the previous modules with the guidance of the Genie. It turns out that it is more favorable to Tong if he changes his mind. Using this tactic, Tong would have a much higher chance in winning the game in the real-time simulation, although we prepared for the highly unlikely event in which Tong lost in the simulation in the story plot.

—Insert Figure 6 here—

Pedagogical Elements

The proposed technique is problem-based learning with an attractive story plot. The reason for choosing a well-known Chinese folklore as the story background is that students are all familiar with it and can fantasize themselves into the Tong Pak Fu role. The main pedagogical tool employed in our system is guided discovery, in which students are assigned tasks and asked questions. Through the carefully arranged sequence of events, each of which embedded into a scene, as shown in Figure 7, student are led through the various kinds of activities including completion of tables, multiple choices, stepwise construction of tree diagrams, and being shown real-time simulations, the last of which demonstrate phenomena and

verify learned concepts and results. Furthermore, if a student fails to give a correct answer in the learning activities, he or she would be given some hints and a chance to try again.

—Insert Figure 7 here—

The final problem "To switch or not switch" is a challenge to the students. It requires students to synthesize what they have learnt and apply to this new situation. The problem is difficult to most of the students, but it is this difficult challenge together with the desire to win Chou that motivates students to try hard in the learning activities.

The Evaluation

Two important elements of this system are problem-based learning and the story plot in additional to that the system is Web-based. To evaluate whether this system can help students to learn better and to investigate what makes it better, we compare our system's effectiveness against that of (a) the traditional lecturing approach without problem-based element and story background, (b) the problem-based approach in the classroom with story background, and (c) the problem-based approach in the classroom without story background. In (a), a teacher conducts lectures to cover various topics in the traditional manner. In (b), a teacher would tell exactly the same Tong Pak Fu story, raise the problems and conduct experiments and simulations using specially constructed teaching aids and tools, and play the role of the Genie. The approach in (c) is similar to (b), except that no story background would be given to the students, who are requested to solve problems without knowing the motivations and contexts. Having done this, we hope to identify elements that make such kind of systems successful.

A total of 499 senior high school students were invited to participate in a one-day programme within our university's campus. In order to attract participants, each activity day was augmented with social activities such as laboratory visit and sight-seeing in addition to the

learning and testing sessions. Taking aside the social functions, each participant completed the following list of activities:

1. Write a pre-test to measure the probability knowledge of the participant.
2. Attend Learning session 1 to cover topics in the first three learning modules using one of the four approaches.
3. Write a post-test to measure the probability knowledge gained in Learning session 1.
4. Attend Learning session 2 to cover topics in the last two learning modules using (possibly another) one of the four approaches.
5. Write a post-test to measure the probability knowledge gained in Learning session 2.
6. Fill out a detailed questionnaire to measure the perception and fondness of the participant towards each of the attended learning approaches.

Research Design

Each student had to attend two learning sessions, one in the morning in which students learned the first three learning modules, and the other one in the afternoon in which the students learned the last two modules. The participants were divided into four groups in the morning, one for each of the four approaches, namely, the traditional lecturing approach (LECT), the problem-based approach in the classroom with story background (PBLS), the problem-based approach in the classroom without story background (PBL), and the Web-based problem-based approach in the classroom with story background (WBLS). The last one is the folklore-based approach under test in the present study.

The aim of the evaluation is to compare the learning effects of the folklore-based approach against the other three. The WBLS approach was conducted with no teacher guidance and supervision, while the other three were conducted by three experienced teachers. For comparing students' perception on different methods, some groups might be assigned to different teaching methods in the afternoon. In order to minimize the teacher effect, the experiment was conducted in 3 separate date periods. In each period, each teacher was assigned to teach using a different approach. The treatment and teacher allocation can be summarized in Table 1.

—Insert Table 1 here—

In the above design, G_{ijk} represents the group of students on the i^{th} day using method j in the morning, and subgroup k. Take week 1 as an example. There are four subgroups, namely G_{111}, G_{112}, G_{113}, G_{114} (day 1, method 1 and subgroups 1, 2, 3, 4 respectively) taking WBLS in the morning. In the afternoon, only one group G_{111} remains with WBLS and all the other 3 subgroups were moved to the other 3 different methods respectively. Since our aim is to compare WBLS with the other three methods, the arrangements for the methods PBLS, PBL and LECT are different. Students are divided into only two subgroups. In the afternoon session, one subgroup of students would remain with the method used in the morning while the other group would be swapped with one of the moving WBLS subgroups. Such an arrangement ensures that some students have chances to learn with two different methods so that comparisons can be performed between WBLS and each of the other three.

Variables

Two instruments were separately developed to measure the students' academic achievement and their perception of the Web-based learning system as compared with the others. The academic achievement is measured by 2 written tests taken separately in the morning and

the afternoon sessions on how well the students learned the topic "Probability" while the students' perception was measured by how they think about the Web-based learning system: whether it is boring, challenging, and stimulating, *etc*. Therefore there is one independent variable, the teacher method, with WBLS, PBLS, PBL and LECT as values, and 2 dependent variables, the academic achievement and the student perception. The academic achievement is composed of the results obtained in two separate tests..

Methods of Analysis and Results

Participants' Attitude Towards Computers. A total of 499 students were invited to attend the experiment which lasted the whole day. Some participants did not show up and some left in the middle of activities. The final number of participants who completed all the tests and questionnaires was 454. Since it is perceived that students' perception on computer games and their experiences in using computers may affect their attitude and hence the results of using computer to learn, we collected the students' background information as summarized in Tables 2 & 3:

—Insert Table 2 here—

—Insert Table 3 here—

On the whole, the participants have a positive attitude towards computer games, graphics, and even learning through computers. They also like communicating with the others by using computers. Although they have little experience in using computer software to learn, such an attitude may cause them to learn more effectively in using computers. Whether this is true will be reported in later paragraphs.

On the other hand, it was also found that only about half of the students like reading. It seems that these students might not be strong in reading skills which may increase their tendency in learning through multimedia packages. Again, this might affect the effectiveness of the system.

Academic Achievement. The academic achievement of a student was measured by summing up his or her test scores in the two tests. Initially no statistically significant difference was found among the four teaching methods (all three *p*-values were larger than 0.6). Upon further investigation, we found that some of the participants were doing extremely well in the pre-test (scoring the highest mark 9 out of 9). In such cases, it is quite impossible that they can get any improvement under either of the instructional methods. We therefore decided to exclude these cases in further analyses. Number of excluded cases can be found in Table 4

No significant differences could be found in the total achievement scores among the different teaching methods. As the achievement was measured with two tests, called Post 1 and Post 2 (each corresponding to the morning and afternoon sessions), and there might be factors that affected what these tests measured, we proceeded to find out the relationship between these measures. The correlation coefficient calculated was 0.302, a significant relationship but quite low if they were meant to measure students' abilities in the same topic.

Multivariate Analysis of Covariate (MANCOVA) was further employed to see whether the teaching method had any effect to the two post-test results as the dependant variables, and students' pre-test results as the covariate. No significant differences could be found either.

Closer inspection of the results for Post 1 and Post 2 separately with Analysis of Covariate (ANCOVA), it was found that the Post 1 results (see Table 5) were generally high (since the subject matter in the morning is relatively easier) and that the distribution was skewed

towards the high end. The effects of the different learning methods might not be reflected due to the Ceiling effect. Figure 8 shows the distribution of the student scores in the test Post 1.

—Insert Table 5 here—

—Insert Figure 8 here—

Significant differences could be found on Post 2 results (see Table 5) among the different teaching methods in the morning session but not those in the afternoon session.

The reason why the learning result was only affected by how the students learned in the morning is not entirely known and deserves further investigations. The following analysis may give some insights on this issue. The post-test scores were further analysed according to the teaching methods students taken in the morning session. Table 6 shows the mean scores of these groups.

—Insert Table 6 here—

Post-hoc analysis showed that significant differences could be found between WBLS and PBL, WBLS and LECT. Results showed that WBLS is better than PBL and LECT; PBLS also out-performed PBL and LECT. Both better approaches, WBLS and PBLS, have a common feature that the learning was guided by a story. This might be the motivating factors for students, and therefore better learning effect is obtained. This might also explain why the methods used by students in the morning are important. Once they were motivated in the morning, they might be more willing to pursue studies further in the afternoon, regardless of the learning methods used. On the other hand, if they found learning boring in the morning, they could not learn well, even with better methods in the afternoon. Thus learning could not be improved.

Perception on the Teaching Methods. As explained earlier, some of the participants used one teaching method in the morning and then another in the afternoon and they were asked to

rate the two methods in 12 questions. Since the aim of this study is to see whether WBLS is better than any one of the three methods LECT, PBL and PBLS, the comparisons were only on WBLS with LECT, WBLS with PBL, and WBLS with PBLS. No comparisons were performed among the three non-Web-based methods. The following paragraphs report the findings.

Students' perception on traditional lecturing approach (LECT) and the Web-based problem-based approach (WBLS) is summarized in Table 7.

—Insert Table 7 here—

As can be seen in Table 7, the participants generally found LECT more boring and that WBLS made the topic more interesting. WBLS could increase their interests in study and improve their creativity. Participants also found, as an advantage of LECT, that they can raise questions any time. However, the effectiveness of LECT depends more on the quality of teachers. The students also found that they have more chances to discuss with classmates in LECT, and that they have less chance to raise questions in WBLS. Lastly, WBLS is more stimulating to their thinking.

Students' perception on Problem-based without Story Background (PBL) and the Web-based problem-based approach (WBLS) is summarized in Table 8.

—Insert Table 8 here—

Similar to the previous comparison, students also found that PBL is more boring than WBLS, and that WBLS could increase students' interests and improve their creativity. Students in the WBLS group disagreed that the problems given to them were unhelpful, and this was even more so for students using PBL. In other words, problems given to students in both teaching methods were found helpful to learn the related concepts, and the effect was statistically significant in PBL. Besides, WBLS allowed students to review the teaching materials more

easily. On the other hand, PBL had the advantage that students could raise questions anytime, although the effectiveness of teaching was more affected by the teacher quality. WBLS also had the disadvantage that students could not have chance to raise questions.

Students' perception on the Problem-based with Story Background (PBLS) and the Web-based method (WBLS) is summarized in Table 9.

—Insert Table 9 here—

Somewhat different results could be obtained when comparing PBLS and WBLS. Similar to the previous comparisons, WBLS allowed students to review the teaching materials more easily. PBLS allowed students to raise questions anytime, although the effectiveness of teaching was more affected by teacher quality. WBLS also had the disadvantage that students could not have chance to raise questions. Interestingly, PBLS was thought to be more suitable for teaching arts subjects and could help students to understand the topic more, while WBLS was more challenging and gave students more confidence. Furthermore, WBLS was found giving more clues to the topic, but PBLS was more helpful for students to memorize the content. Such differences were not found in the previous comparisons of the other pairs.

The four teaching methods can be categorized according to two criteria. The first criterion is in terms of teacher presence. WBLS was the only one that did not require a teacher to conduct the lesson. It was found that all the three methods that require teachers' presence did have a common advantage over the Web-based approach: under these three methods, students can raise questions any time, but these methods would very much depend on the teacher quality. On the other hand, two of the methods LECT and PBL, which require teacher presence, were found boring, less interesting, and comparatively less able to increase students' creativity when compared with WBLS. Furthermore, WBLS was found more stimulating than these two methods.

The second criterion is on story background. WBLS is actually the Web version of PBLS. They both have the story background, but the latter was conducted by a teacher. Comparing these two, we found that there was no evidence showing that PBLS is more boring or less interesting. This result might imply that the presence of a teacher may not be the direct cause of whether a lesson is boring or interesting. Further, it was found that PBLS was more challenging, and could help students understand and memorize better than WBLS. In other words, if learning materials are presented with story backgrounds, students will be motivated, no matter whether there are teachers there to help. The presence of teachers, however, does help to guide and encourage students to explore within the learning environment. Results of this analysis agree with the previous analysis on academic achievement. Motivating students' interest by using a story background may be essential for a teaching method to be effective.

Conclusion and Discussion

Results show that the effect of learning methods with story background is better than those without. The success of such learning systems, called folklore-based systems, assures us that it is a kind of learning paradigm that deserves further exploration. Furthermore, there was no significant difference found between the two folklore-based approaches, WBLS and PBLS, one with the presence of teachers and the other without. This is also encouraging, since a teacherless method can now achieve equal effectiveness as those conducted by experienced teachers. Furthermore, this folklore-based learning system was considered by the students as less boring, more challenging, and more stimulating, and at the same time giving them more confidence. All these are important factors in motivating students to learn. It is believed that, if students' interest persists, and with the improvement of the system, folklore-based learning system can be an important learning tool in the near future.

The analyses of students' perceptions on the four teaching methods also shows that the story background might be the reason that motivates students to learn. Further explorations on this should be an important direction for future research.

We would also point out that since the students participated in this experiment have strong tendencies and the relevant knowledge in using technology to learn, the results obtained may therefore be biased. In the future, a more random sample should be used so that a more generative result can be obtained.

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Table 1

Treatment and Teacher Allocation Table

	Week 1		**Week 2**		**Week 3**	
Teaching Methods	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
WBLS	G_{111} G_{112} G_{113} G_{114}	G_{111} G_{122} G_{132} G_{142}	G_{211} G_{212} G_{213} G_{214}	G_{211} G_{222} G_{232} G_{242}	G_{311} G_{312} G_{313} G_{314}	G_{311} G_{322} G_{332} G_{342}
PBLS	G_{121} G_{122}	G_{121} G_{112}	G_{221} G_{222}	G_{221} G_{212}	G_{321} G_{322}	G_{321} G_{312}
PBL	G_{131} G_{132}	G_{131} G_{113}	G_{231} G_{232}	G_{231} G_{213}	G_{331} G_{332}	G_{331} G_{313}
LECT	G_{141} G_{142}	G_{141} G_{114}	G_{241} G_{242}	G_{241} G_{214}	G_{341} G_{342}	G_{341} G_{314}

* G_{ijk}: The groupgroup of students on the i^{th} day, method j in the morning, and subgroup k

Table 2

Participants' attitude in using computer

	Yes (%)	**No (%)**
Do you like playing computer games?	83.4	16.6
Do you like computer graphics?	89.4	10.6
Would you like to study aided by computer?	81.9	18.1
Do you like to read through textbooks and reading materials?	55.7	44.3
Do you value communications with teachers and classmates?	95.2	4.8
Would you like to study using computer games with story background?	85.9	14.1
Have you tried the teaching method using computer games with story background before?	31.0	69.0
Do you like this computer teaching software?	88.1	11.9
Do you like this particular story background of Tong Pak Fu?	90.8	9.2

Table 3

Participants' experience in using computer

On average, how many hours would you spend on playing computer games every week in January, 2002?	0 – 5 hours	62.3%
	6 – 10 hours	20.9%
	11 – 15 hours	7.8%
	16 hours or more	9.1%

Table 4

Number of Excluded Cases (scoring the highest mark 9 out of 9 in pretest)

	WBLS	PBLS	PBL	LECT
No. of Subjects	73	42	27	37
Total No. of Subjects	174	93	95	92
%	41.9	45.1	28.4	40.2

Table 5

Multiple analysis of covariate of the post-test results – Tests of between subjects effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Post 1	57,396[a]	10	5.740	2.389	0.010	0.083
	Post 2	42,304[b]	10	4.230	2.481	0.007	0.086
Intercept	Post 1	251,373	1	251,373	104.612	0.000	0.284
	Post 2	59.280	1	59.280	34.759	0.000	0.116
T_MORNIN	Post 1	14.064	3	4.688	1.951	0.122	0.022
	Post 2	15.779	3	5.260	3.084	0.028	0.034
T_AFTERN	Post 1	5.060	3	1.687	0.702	0.552	0.008
	Post 2	3.771	3	1.257	0.737	0.531	0.008
T_MORNIN*T_AFTERN	Post 1	4.952	3	1.651	0.687	0.561	0.008
	Post 2	16.095	3	5.365	3.146	0.026	0.035
PRE	Post 1	22.391	1	22.391	9.318	0.003	0.034
	Post 2	4.466	1	4.466	2.618	0.107	0.010
Error	Post 1	634,364	264	2.403			
	Post 2	450.241	264	1.705			
Total	Post 1	12,097.000	275				
	Post 2	3,089.000	275				
Corrected Total	Post 1	691.760	274				
	Post 2	492,545	274				

a. R Squared = .083 (Adjust R Squared = .048)

b. R Squared = .086 (adjusted R Squared = .051)

Table 6

Mean scores of the different teaching method groups in the morning session

Method	Mean	N	Std. Deviation
WBLS	3.33	105	1.313
PBL	2.75	51	1.521
PBLS	3.21	68	1.100
LECT	2.76	55	1.360
Total	3.08	279	1.335

Table 7

Comparison between LECT and WBLS

Question	LECT		WBLS		*p*-value
	Mean	SD	Mean	SD	
I like this teaching/learning method.	6.15	1.658	6.32	1.678	.530
This teaching/learning method is suitable for arts subjects.	6.05	2.233	6.22	2.152	.652
This teaching/learning method is suitable for science subjects.	6.24	1.982	6.43	2.038	.558
This teaching/learning method is suitable for commerce subjects.	5.59	1.791	6.01	1.845	.122
This teaching/learning method is suitable for the topic of Probability.	5.95	1.762	6.34	2.200	.162
This teaching/learning method is boring.	6.31	2.251	4.27	2.128	.000
This teaching/learning method makes the topic more interesting	4.20	1.909	7.12	1.843	.000
Under this teaching/learning method, I can understand the topic more easily.	6.10	2.000	6.06	1.843	.875
This teaching/learning method can increase my interests in study.	4.94	1.930	6.69	1.954	.000
This teaching/learning method can improve my creativity.	4.51	1.902	6.37	2.041	.000
Under this teaching/learning method, study becomes more challenging.	5.44	2.199	5.80	1.814	.229
This teaching/learning method gives me more confidence in study.	5.66	2.015	5.47	1.957	.474
The problems provided in this teaching/learning method are not helpful at all. (Not applicable to traditional teaching.)			4.81	1.991	.000
I can review the materials any time until I fully understand the topic.	6.67	2.317	7.34	2.026	.051
I can raise questions to the teacher any time I	7.18	2.196	4.44	2.294	.000

want.					
The effectiveness of teaching depends on the quality of the teacher	8.62	1.796	4.15	2.447	.000
The teacher can help me understand the topic. (Not applicable to Web-based learning.)	7.09	1.843			.000
I can discuss with classmates any time.	6.79	2.174	6.15	2.726	.047
During this program, I did not have any chance to raise questions at all.	3.54	1.935	6.27	2.726	.000
This teaching/learning method is stimulating to my thinking.	5.13	2.144	6.32	2.007	.000
This teaching/learning method does not give any glue to the topic.	3.79	1.889	4.19	2.252	.117
This teaching/learning method is helpful in memorizing the content.	6.06	2.002	6.08	1.959	.939

Table 8

Comparison between PBL and WBLS

Question	PBL		WBLS		*p*-value
	Mean	SD	Mean	SD	
I like this teaching/learning method.	6.41	1.767	6.88	1.682	.088
This teaching/learning method is suitable for arts subjects.	5.79	2.097	6.57	2.126	.450
This teaching/learning method is suitable for science subjects.	6.62	2.177	6.62	2.009	.942
This teaching/learning method is suitable for commerce subjects.	6.12	1.792	6.21	1.912	.664
This teaching/learning method is suitable for the topic of Probability.	6.46	1.855	6.71	1.844	.443
This teaching/learning method is boring.	5.58	2.583	4.01	2.117	.000
This teaching/learning method makes the topic more interesting	5.41	2.293	7.22	1.847	.000
Under this teaching/learning method, I can understand the topic more easily.	6.61	1.778	6.34	1.903	.259
This teaching/learning method can increase my interests in study.	5.92	2.018	7.26	1.732	.000
This teaching/learning method can improve my creativity.	5.27	2.207	6.62	2.123	.000
Under this teaching/learning method, study becomes more challenging.	6.24	2.002	6.31	1.964	.867
This teaching/learning method gives me more confidence in study.	6.11	1.751	6.07	1.907	.819
The problems provided in this teaching/learning method are not helpful at all. (Not applicable to traditional teaching.)	3.54	1.973	4.11	2.074	.004
I can review the materials any time until I fully understand the topic.	5.93	2.140	7.13	2.084	.000
I can raise questions to the teacher any time I want.	7.32	2.205	4.53	2.577	.000
The effectiveness of teaching depends on the quality of the teacher	8.40	1.672	4.43	2.634	.000
The teacher can help me understand the topic. (Not applicable to Web-based learning.)	6.90	1.826			.000
I can discuss with classmates any time.	7.08	1.895	6.60	2.259	.144
During this program, I did not have any chance to raise questions at all.	3.85	2.267	6.10	2.555	.000
This teaching/learning method is stimulating to my thinking.	6.62	2.047	6.62	1.859	.969
This teaching/learning method does not give	3.56	1.799	4.18	2.026	.006

any clue to the topic.					
This teaching/learning method is helpful in memorizing the content.	6.28	2.149	6.70	2.085	.167

Table 9

Comparison between PBLS and WBLS

Question	PBLS		WBLS		*p*-value
	Mean	SD	Mean	SD	
I like this teaching/learning method.	6.99	1.462	6.65	1.762	.115
This teaching/learning method is suitable for arts subjects.	6.86	1.986	6.21	2.212	.019
This teaching/learning method is suitable for science subjects.	6.60	1.904	6.70	1.986	.666
This teaching/learning method is suitable for commerce subjects.	5.99	2.181	6.18	2.229	.341
This teaching/learning method is suitable for the topic of Probability.	6.88	1.990	6.49	2.062	.086
This teaching/learning method is boring.	3.99	2.343	4.16	2.348	.501
This teaching/learning method makes the topic more interesting	7.12	1.958	6.72	2.232	.093
Under this teaching/learning method, I can understand the topic more easily.	6.60	2.023	5.85	2.092	.001
This teaching/learning method can increase my interests in study.	7.04	1.978	6.69	2.125	.173
This teaching/learning method can improve my creativity.	6.09	2.325	6.01	2.272	.766
Under this teaching/learning method, study becomes more challenging.	5.51	2.201	6.27	2.315	.005
This teaching/learning method gives me more confidence in study.	5.89	1.956	5.44	2.127	.036
The problems provided in this teaching/learning method are not helpful at all. (Not applicable to traditional teaching.)	3.65	2.327	3.70	2.209	.754
I can review the materials any time until I fully understand the topic.	6.32	2.367	7.38	2.135	.000
I can raise questions to the teacher any time I want.	6.60	2.463	4.40	2.587	.000
The effectiveness of teaching depends on the quality of the teacher	7.14	2.751	4.15	2.811	.000
The teacher can help me understand the topic. (Not applicable to Web-based learning.)	6.89	2.110			
I can discuss with classmates any time.	7.02	2.150	6.72	2.446	.289
During this program, I did not have any chance to raise questions at all.	4.00	2.245	5.36	2.692	.000
This teaching/learning method is stimulating to my thinking.	6.64	2.052	6.48	2.250	.518
This teaching/learning method does not give any clue to the topic.	3.20	1.879	3.85	2.361	.007

This teaching/learning method is helpful in memorizing the content.	6.78	2.244	6.16	2.335	.009

Figure 1. Example of Fill-in-the-blank exercises to guide student learning

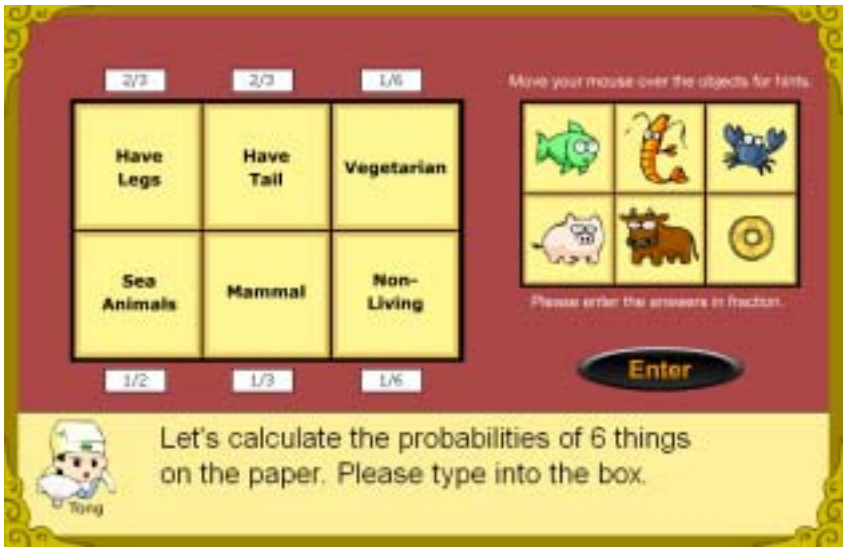

Figure 2. Example of real-time simulation and verification of concepts

Figure 3. Tree Diagram that explains the possible outcomes of a Holy Cups Throw

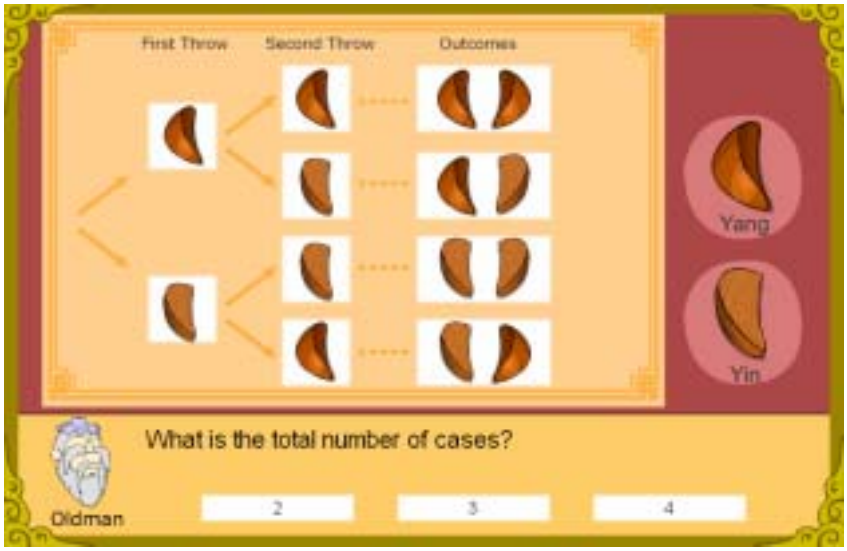

Figure 4. Crooked Dice used by the Kids to cheat Tong

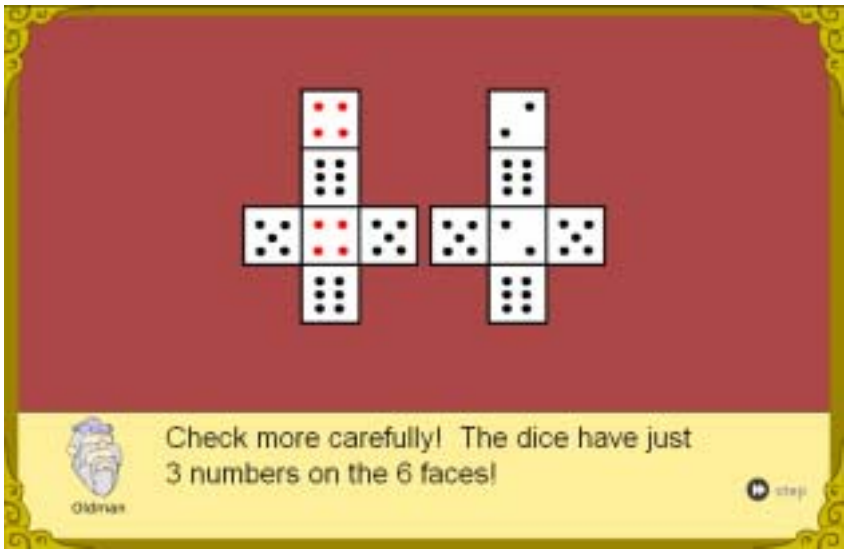

Figure 5. Tree Diagram for analyzing the Coin-guessing Game

Figure 6. The Bride-picking Game

Figure 7. Sequence of Learning Events

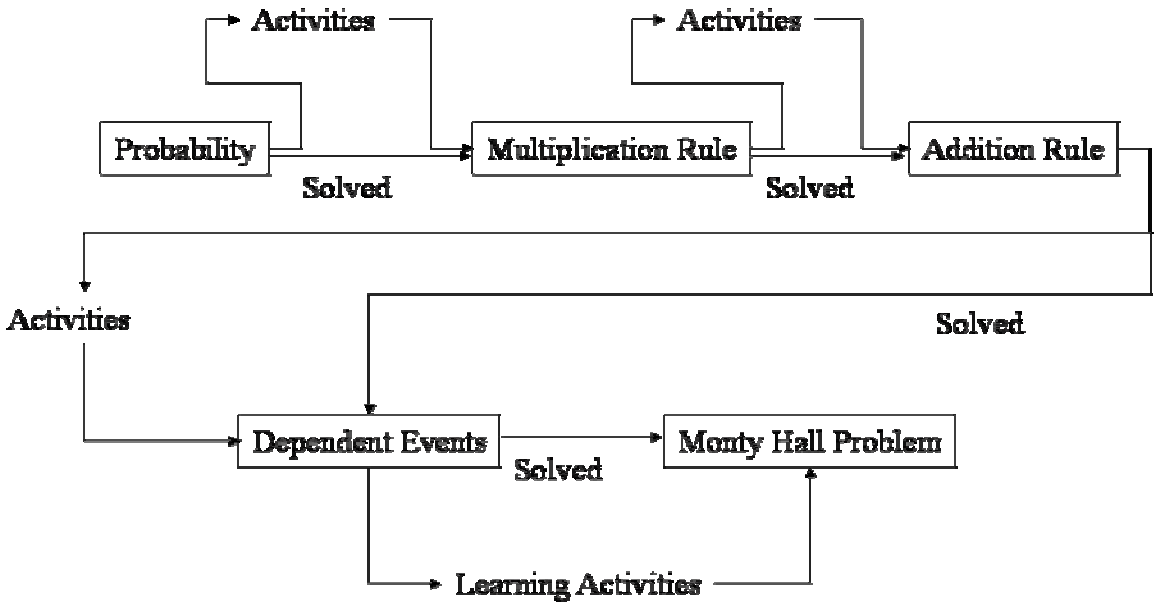

Figure 8. Distribution of scores of the post-test (Post 1) taken in the morning