Proceedings of the Sixth IASTED International Conference
WEB-BASED EDUCATION
March 14–16, 2007, Chamonix, France
ISBN Hardcopy: 978-0-88986-650-8 / CD: 978-0-88986-651-5

A WEB-BASED LEARNING ENVIRONMENT SUPPORTING INQUIRY THROUGH PLAYFUL DESIGN EXPERIENCE

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ABSTRACT

This paper describes our web-based design, Juming Museum Explorer (http://artsnsc.tmue.edu.tw/juming-en/index.html) to support students' inquiry learning. By integrating educational theory with advanced technology, we provide students with a fun and playful environment where they can explore, experience, and create their original work. We chose the Juming Museum in Taiwan as an example where we can apply our general model to improve the students' learning in Art and Art Appreciation. We believe that our design experience can be generalized to other subject areas. This is a condensed English version of a web learning website http://arts.edu.tw/ that we designed and have successfully used in Taiwan schools.

KEY WORDS

Web-based, Inquiry Learning, Juming Museum, Art, Art Appreciation

1. Introduction

Last year, we conducted a web-based inquiry learning experiment with approximately 200 teachers of grades 1-9 from 52 schools of 17 counties in Taiwan. The project was concluded with a competition and survey to assess the impact of our project on students' inquiry learning. As general framework we adopted the WebQuest format [1], which is defined as "an inquiry-oriented activity in which most or all of the information used by learner is drawn from the Web. WebQuests are designed to use learners' time well, to focus on using rather than looking for it, and to support learners' thinking at the levels of analysis, synthesis and evaluation." [2]. This experience is precious in a way that we were able to observe many real-life teaching situations and had a chance to interview many teachers and students. Our findings [3] show that majority of the students had a productive WebQuest learning experience with very positive outcomes, although some teachers were confused when they were to apply inquiry teaching or direct teaching. However, we also noticed some limitations: most of their web activities were mainly limited to information gathering. If design work is part of the project, it most likely is done off-line, not web-based. Moreover, most of students' motivation for doing WebQuests came from the fact that they were assigned as homework. This is far from the self-driven motivation (intrinsic motivation) that one would like to achieve.

The idea of inquiry, or discovery, as a learning approach has a long history [4], is defined as "an approach to learning that involves a process of exploring the natural or material world, and that leads to asking questions, making discoveries, and rigorously testing those discoveries in the search for new understanding" [5]. But the inquiry teaching may not fit in acquiring all kind of knowledge, a sound curricula combine different forms of tuition, both inquiry learning and direct instruction. Inquiry learning may be more effective in acquiring intuitive, deep, conceptual knowledge; direct instruction and practice can be used for more factual and procedural knowledge [6]. Unguided inquiry is generally found to be an ineffective way of learning [7]. Research in inquiry learning currently focuses on finding scaffolds or cognitive tools that help to produce effective and efficient learning situations. With Advanced technology, we believe it can support inquiry learning in many ways.

2. Purpose of This Design

In this design we try to provide an innovative way to provide students with a playful learning and design environment. The design should be attractive for students and encourage them to learn with intrinsic motivation in a web-based learning environment. We use "Juming Museum Explorer" as example to demonstrate how to enhance inquiry learning by state-of-the-arts tools provided to students within a web-based environment; it allows students to explore, experience, and create.

3. Juming Museum Explorer

In the following, we will discuss this "Juming Museum Explorer" design.

3.1 The general philosophy behind this design

3.1.1 For the students

(1) Provide multiple learning paths

In traditional school teaching, for instance in music class, we find that many teachers try to teach students the

basic theory first. They teach them to recognize all the notes in the score, the sharp, flat, etc. before asking students to compose music. They think these theoretical items are a prerequisite for composition. Because different children learn better in different ways, this may fit some students and not others. Sometimes, however, it even frightens children or lessens their interest in music. Some children even learn better in reverse. If they really feel like creating music or want to play a favorite song on the piano, they might feel the need to learn the notes. Then the learning becomes truly meaningful for them. Therefore it is important to provide children with multiple learning paths. The web environment is optimal in serving this goal; since on the Internet, there are much fewer restrictions than there are in the natural environment of most children.

(2) Provide multimedia authoring tools for design

When creating music or pieces of art, we go through the process of organizing elements into a composition. This experience helps us to have a deeper understanding of the meaning of those elements that go into the composition or artwork. What we learned from this example has a more general function in the learning processes that involve design: "Design activities engage children as active participants, giving them a greater sense of control over (and personal involvement in) the learning process, in contrast to traditional school activities in which teachers aim to "transmit" new information to the students." [8].

As shown in Figure 1, we created an authoring tool called "My *e*Card". Through this tool a student can design an electronic postcard, which records the history of his/her creative process together with a musical sound track. Viewing the process of creating the *e*Card (shown in Figure 2) is much more attractive and instructive than only looking at a finished picture.

Figure 1: User interface of "My *e*Card", http://arts.edu.tw/game/game/MyEcard3_e.php

In a web environment, modern technology not only can provide online authoring tools for design but also allow recording the creative process that can later be played back in an exhibit. The exhibit can be published on the web and provide opportunities for reflection and discussion. Observing and analyzing the children's process can be very helpful for teachers in guiding the students' learning.

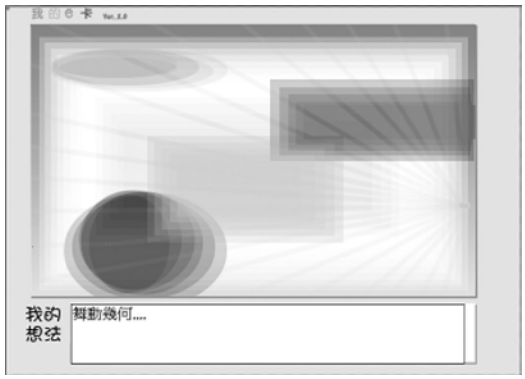

Figure 2: Example of student's work using "My eCard", http://arts.edu.tw/game/game/MyEcard3.php?pieceID=20416&S_Id=&ReadOnly=true

(3) Provide scaffolds for learning and design

We often find that obstacles to children's learning come from manipulating too many variables at once. For instance, it is even difficult for an advanced violinist to take care of perfect intonation, articulation, bow stroke, and expression all at the same time. Similarly, in painting, not all children are skillful in drawing. Providing some prepared graphics or music can make it easier for them to design an animation and to reduce their fear of trying. Modern technology can be very efficient for providing different levels of design tools for students.

As shown in Figure 3, we created an authoring tool called "My Oriental Garden". By providing graphical elements of the oriental style (shown in Figure 3) together with music, students can easily create an oriental garden. This is one example of providing scaffolds for design that can encourage less advanced students to create their own works; they do not have to manage so many variables at the same time. It records the complete design process, which can be played back later, as shown in Figure 4.

Figure 3: Shows the elements are prepared for being used. http://arts.edu.tw/game/game/MyEcard2_e.php

(4) Provide interactive computer simulation for hands-on experimentation

Modern technology is also very good at providing simulations for students to experience some conceptual knowledge. By changing the variables, students can easily experience the different conditions.

Figure 4: Example of a student's creation, http://arts.edu.tw/game/game/MyEcard2.php?pieceID=3189&S_Id=&ReadOnly=true

As shown in Figure 5, we created an authoring tool called "Space Alien". Here a student can learn about mixing of the primary colors: Red, Green and Blue (RGB). By using the sliders on the left, he/she can adjust the percentage of the color for the alien to match that of the alien on the wanted poster. When he/she thinks the colors are relatively close, he/she can press the "Done" button. Then the alien will be sent to the mother ship in the outer space for a review. The returned answer will show how well they have matched the color of the alien with that on the wanted poster.

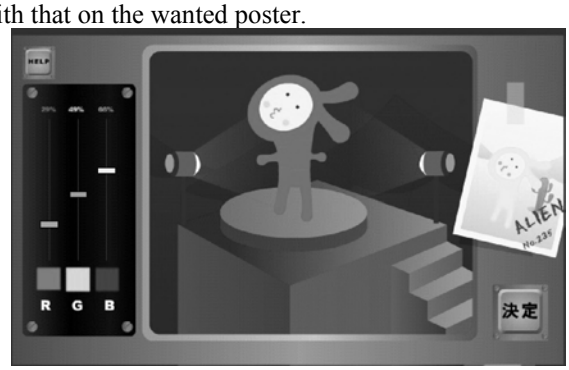

Figure 5: Interface of the Space Alien color mixing game, http://artsnsc.tmue.edu.tw/color/color.html

3.1.2 For the Teachers

From our experience of working with several hundred lower and middle school teachers in Taiwan, we came to the conclusion that most teachers are far from being "fluent" in technology [9]. Thus, in order for a new program to be adopted in a school, we have to keep the technology requirements at a minimum. Since teachers are busy with the school's daily work, or routines, or duties, it is also very helpful to support them with convenient teaching design input interfaces.

3.2 The Juming Museum Explorer

3.2.1 Design Procedure

The following are the steps in creating the learning content:

(1) Identify topics that arouse student interest.
(2) Identify which aspects of learning content are best suited for implementation as web based learning tools. This has to be evaluated under known constraints of teacher skills, budget limitations and other factors.
(3) Design a teacher's reference guide, for example a WebQuest format, to support the teachers' teaching. The example will be showed as below.

3.2.2 The criteria for selecting this topic

In this study, we selected the Juming Art Museum located in Northern Taiwan as an example to demonstrate how modern web technology can help students in their Art Appreciation and Art class. We start with a focus point that catches the students' attention from the beginning, and then build up a playful web environment. There are several reasons why we chose the Juming Museum as backdrop for this learning program.

Firstly, it has a very natural learning environment. The exhibited works are allowed to interact with nature, giving the visitor unknowingly the chance to become part of the creation and to be integrated into the entire environment.

Secondly, this can be a good example for the fact that with the help of technology, one can learn about a museum before visiting it in person. Some children might not have the opportunity to visit such a unique museum in person because of its location; children who are able to visit in person might be overwhelmed by the huge amount of novel information that they are confronted with in such a short time.

3.2.3 Technical tools used for implementation

In this "Juming Museum Explorer" program, we apply the RIA (Rich Internet Application) technique. It uses the Flash Player as the front-end, and applies Flash and Action Script to produce the visual effects and logic operations as well. It is also assisted by PHP as the bridge for data processing. It is connected to the database, which includes Web services, at the post-end to provide the interfaces for games and management. All the interfaces for management will work with web-browsers, and would not be confined by the hardware and operating system it is using.

3.2.4 For the students

In order to provide the students multiple learning paths, in this "Juming Museum Explorer" design, we provide six learning areas as Figure 6 for the students to explore. These six learning areas are: (1) Game Area, (2) Creation Area, (3) Gallery Area, (4) Information Area, (5) Self-Evaluation, and (6) WebQuests.

Each of these areas is closely related to the Juming Museum; students can start with either one at first. In this way we provide the students with multiple learning paths.

Based on this idea, the entry homepage is designed as shown in Figure 7 and Figure 8. In Figure 7, students can click on the sign to take the bus to the museum. The first screen that students see as they arrive at the museum is an interactive birds-eye view of the museum grounds as shown in Figure 8. We can see a signpost that invites the students to wander off and explore different parts of the museum complex. Dangling from a tree we see binoculars that the student can use to get a close-up view of the artwork in the museum.

Figure 6: The learning structure of the Juming Museum Explorer

Figure 7: The entry page of the Juming Museum Explorer, http://artsnsc.tmue.edu.tw/juming-en/station.html

Figure 8: Interactive map of the Juming Museum Explorer, http://artsnsc.tmue.edu.tw/juming-en/index.html

(1) Games Area

In this interactive game area, two games are offered as follows.

(a) "Changing Texture":

This "Changing Texture" game (shown in Figure 9) is aimed to provide interactive computer simulation for hands-on experimentation. It could allow the students to learn about the textures of the art exhibits. The task is to determine which texture, among four sample textures, matches the art object under examination. The students see four different samples of the texture: tree-bark, gold powder, iron metal and stonewall. This game heightens the students' sensibility of texture as an essential dimension of artistic expression.

Figure 9: Side-by-side display of Juming art object rendered with different textures.

(b) "Super Puzzle":

As shown in Figure 10, this "Super Puzzle" game is designed to provide an interesting game interface to reinforce student's memory on the learning content. It applies the puzzle paradigm to focus students' attention on the different elements of each of the exhibits. In this game, the students are asked to arrange twelve puzzle elements from one of 25 art pieces in the proper order. The time it takes them to solve this puzzle will determine their score for this game. The design of this game is based on state of the art in active web-design techniques. That means the displayed images are dynamically generated from a database that is provided by the teachers. This makes the game extremely flexible and portable for different subject areas.

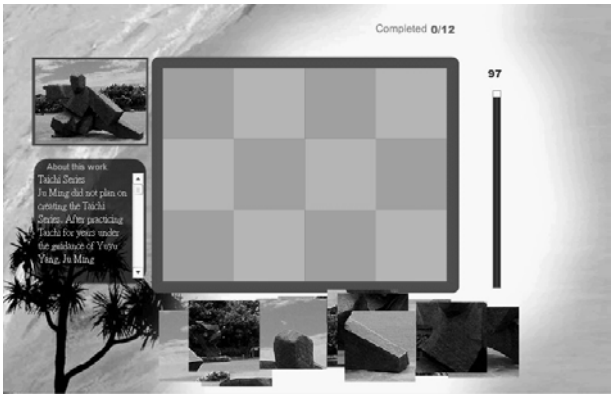

Figure 10: Puzzle game to teach elements of art objects

(2) Creation Area

In the "Creation Area" of this "Juming Museum Explorer", we designed an interface (shown in Figure 11) called "My Artistic View". It is to provide scaffolds for

learning and design. We provide the students with several choices of Ju Ming's artwork. By changing the backgrounds pictures and different setting for the artwork, students can learn more about their relation to a chosen environment. Among the parameters that a student can control over are: 3D perspective of the artwork within the student selected scene, orientation and scaling of the piece of art, and weather condition at the location (sunshine, rain, snow).

For most students, to draw such a picture is difficult, but it's very easy for them to use this tool to create interesting images. This is also a good way to encourage students to creative design.

Figure 11: User interface of "My Artistic View"

(3) Gallery Area

In here, students can see the others' works; this is a good chance to learn from their peers. In the future, we hope to provide this function for the students to discuss, and for the teachers to input their comments.

(4) Information Area

This area is designed to provide a web title to attract the students' attention. Not all students like to read plain text. By embedding pictures and stimulating graphics in the text information in an interesting way, therefore, we can encourage students to improve their reading habits.

In the "Information Area" of this "Juming Museum Explorer", the students can learn about the background and characteristics of the Museum, the artist Ju Ming and his three different artistic styles representing different periods in his creative life. This section is divided into three parts: (a) Site Characteristics, (b) Ju Ming's Biography, and (c) Artistic Expression.

(5) Self-Evaluation

Here the students can have a chance to evaluate how much he/she knows.

(6) WebQuests

Here the students can start their inquiry work followed by the WebQuests that teachers provided.

3.2.5 For the teachers

In order for the teachers use this program easily, we provide them with convenient teaching design input interfaces. In the following we provide three elements of our general design:

(1) Provide a template for teachers to input their instructional plan, for instance, the WebQuests, to pass on to the students for guidance.

(2) Provide a quiz template as shown in Figure 12 so that teachers can input their specific questions to assess the students' knowledge and understanding on the teaching material. It can be easily modified and adapted by the teachers without consulting with a web designer.

(3) Design a teacher's reference guide, for example a WebQuest format, to support the teachers' teaching. The example will be showed as below.

Figure 12: Teacher's Quiz Input Control

4. Example of an Inquiry-based Instructional Plan

In this project, we designed an instructional plan in the WebQuest format for teachers' reference. This example differs from the standard WebQuest approach. It is not a linear sequence of sub-processes that the students have to follow; however, it provides different paths for students' choice. They can start with either task. Because of the limited space we only include the first two sections Introduction and Tasks, of a complete WebQuest, and omit the sections of "Process, Resource, Evaluation and Conclusion".

Place a Juming Sculpture in Your Community

Introduction:

The internationally renowned artist Juming is considering donating a piece of his art to your community. But you need to convince him that you understand his art, and how his art would befit your community. In order to select a piece of art most appropriate for your community, there are several tasks you can try to complete. The more tasks you are able to complete, the better chance you have that your community will be selected to receive the piece of art.

Tasks:

Task I: Explore Juming's art expression

Task II: Explore the meaning of public art

Task III: Create your own artwork

5. Evaluation

During the development of this research project, we received frequent feedbacks from the art teachers of Jin-Shan Junior and Middle High School, Taipei, Taiwan. The most recent survey was done last semester in Jin-

Shan Junior and Middle High School. It involved 100 students.

This is still a preliminary investigation and more detailed analyses are in preparation.

The following are the questions used in the survey:

1. This web-based learning helps me better understand Juming's art works.
2. This web-based learning helps me better understand the artistic expression of sculpture.
3. This web-based learning helps me better understand that artworks can create different feelings to the viewer depending on where it is located.
4. This web-based learning helps me better understand the meaning of public art.
5. This web-based learning helps me have a better understanding of the Juming Museum.
6. This web-based learning helps me not to be afraid of art.
7. This web-based learning helps me feel like trying to create my own art works.

As shown in Table 1, the results show that most students find this learning program helpful to improve their art appreciation. The area need to improve is related to question 7 that received the lowest score of the survey, although 3.5 is still relatively strong. It shows that not all the students are comfortable on creating their own artwork; however, this program helped them to become less intimidated by art. These psychological factors could be identified as important questions for future studies after this very promising start.

Table 1: The results of the preliminary investigation

Q	Strongly agree (5)	Agree (4)	No opinion (3)	Disagree (2)	Strongly disagree (1)	Average
1	70	20	5	3	2	4.53
2	65	25	6	3	1	4.5
3	60	25	5	6	2	4.29
4	45	35	8	2	2	3.95
5	65	28	5	2	0	4.56
6	60	30	5	2	3	4.42
7	25	35	20	10	5	3. 5

6. Conclusion

A web-based design to support students' inquiry learning has been presented. By integrating educational theory with advanced technology, we provide students with a fun and playful environment where they can explore, experience, and create their original work. We chose the Juming Museum in Taiwan as an example where we apply our general model to improve the students' learning in Art and Art Appreciation. From the results of evaluation, it has been proved to be helpful. The Juming Art Museum presented here is only an example; there are many more interactive game-type learning tools, on line design tools and reward systems that can be developed on the web. We believe that the experience of this example can be reproduced in other subjects/areas.

In the future study, we plan to design environments that involve collaborative learning and multi-user design tools. We believe that this will greatly benefit students since it will extend web-based learning to include elements of "social intelligence", whose significance for learning has only been recognized recently [10].

Acknowledgments

Thanks to Ming-Da Shieh, Shin Chuan Chen, Dr. Yi-Cheng Wu and all the members of our research team. The valuable support from the Juming Museum, Taiwan, by providing digital images and references is gratefully acknowledged.

The author would like to thank Professor Mitchel Resnick of the MIT Media Lab for his generous support and stimulating discussions, and to Dr. Gottfried Mayer for his help in preparation of this paper. This work was made possible by Grant #0940111650 from Ministry of Education of Taiwan and Grant #NSC-93WFA0A00092 from the National Science Council of Taiwan.

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