APEC Cyber Academy: Integration of Pedagogical and HCI Principles in an International Networked Learning Environment

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ABSTRACT

This chapter introduces how APEC Cyber Academy, an international networked learning environment designed for K-12 students, can foster global collaboration through the integration of sound pedagogy and human-computer interaction (HCI). Pedagogical principles that encourage project-based learning, knowledge construction, collaborative learning, community building, and critical thinking are incorporated into the design of this human-computer interface. Furthermore, HCI is enriched by 3D virtual reality, multi-player games, an intelligent agent, video/voice conferencing, text-to-speech technologies, and instructional modules that are rooted in constructivist and self-regulated learning. APEC Cyber Academy provides a platform for engaging students in global collaboration and increasing information and communications technology (ICT) skills.
INTRODUCTION

Web-based learning environments have become an integral part of both traditional face-to-face and online education. Most Web-based learning environments have such basic tools as content management, course delivery, discussion board, and assessment. The functionalities of a Web-based learning environment can either dictate or extend the instructional activities that a teacher can apply to the classroom. Over the past five years, the boom of e-learning has contributed to the creation of more course management systems that are designed to provide better accessibility to students. Although many of the systems claim to support pedagogical visions with good human-computer interface that encourages peer collaboration, knowledge construction, mentoring, and community building, most systems are designed largely for college or adult learners and only manage syllabi and instructional content. Bonk and Dennen (2003) found most online courseware to be pedagogically and interaction negligent. Several sources have reported international standards for HCI and usability. Among others, these standards include guidelines on functionality, interface, interaction, and use of graphics and multimedia (Bevan, 1995; Nielsen, 2004; Shneiderman, 1998; UsabilityNet, 2006). Functionalties that assist the development of rich interaction, reflection, problem-based, or project-based learning are largely missing. Very few Web-based learning environments provide pedagogical tools and quality HCI to support good human-computer interaction and collaboration among international K-12 learners.

APEC Cyber Academy, a networked learning environment, was originally designed for K-12 students of APEC (Asia Pacific Economic Cooperation) member economies and was developed to address the specific vogues in pedagogy and HCI that are essential for supporting international collaboration among K-12 learners (primary and secondary school learners). APEC Cyber Academy (http://linc.hinet.net/apec/) is built on a learner-centered paradigm that provides project-based learning programs and a rich international learning community. The original intent was to provide a place for students and teachers to communicate and engage in virtual learning experiences in international context. Launched in 2002, the project is hosted by APEC Digital Content Production Center currently under the auspices of APEC/EDNET and Ministry of Education of Taiwan. With its emphasis on active learning and creative digital content, APEC Cyber Academy has attracted a growing number of international users, including K-12 students and teachers. As of December 2005, there are more than 10,000 registered learners from countries around the world (see Table 5). This chapter will provide a framework for applying pedagogical and HCI principles in virtual learning environments appropriate for young learners.

THEORETICAL FRAMEWORK

Constructivism

Some constructivist schools of thought focus primarily on the individual learner, while others focus primarily on the social nature of knowledge construction. The consensus is that education is not the mere transmission of knowledge from the teacher to the student but requires that students be active. At one end is radical constructivism, which attributes its origins to Von Glasersfeld (1978, 1985), who proposed that knowledge is constructed from individual experience. On the other end is cognitive constructivism as suggested by Jean Piaget (1969, 1970), who proposed that knowledge is constructed from individual experience. In between these two extremes is the notion of social constructivism, which has its origins in the theories proposed by Lev Vygotsky. Social constructivism gives importance to cultural and social contexts.
in influencing learning, namely the role of the community and people.

The design and development of the *APEC Cyber Academy* is steeped in the tradition of constructivist (Vygotsky, 1978) and self-regulated learning theories (Bandura, 1997). Contextual learning and collaboration are strongly supported in the networked learning environment. Constructivism is a perspective that has tremendous influence on the design of emerging learning environments. According to Jonassen and Reeves (1996), constructivism explores the process of constructing meaning and knowledge in the world. They stipulated that:

> how we construct knowledge depends on what we already know, our previous experiences, how we have organized those experiences into knowledge structures such as schemata and mental models, and beliefs that we use to interpret the objects and events we encounter in the world. (p. 695)

Constructivism theorists who are influenced by Vygotsky posit that knowledge is constructed through the appropriation of culturally relevant activities. In other words, knowledge is co-constructed with peers or experts and through immersion in a social context (Bonk & Cunningham, 1998). Through engagement in collaborative activities, learners could gain new insights or knowledge as a result of collaboration. Collaboration facilitates the acquisition of knowledge. Furthermore, greater learning takes place in a social process of knowledge construction than individual effort. In Vygotsky’s view, the artifacts in the social and cultural environments play an important role in assisting the development of the mind (Cole & Wertsch, 1996). Learning does not exist only inside the head of an individual, but also through culturally mediated artifacts distributed in the environment. In a networked learning environment, representation of artifacts plays an even greater role in facilitating knowledge construction and collaboration (Suthers, Hundhausen, & Girardeau, 2003). The constructivism theory has played an important role in the design of many learning environments (Lakkala, Rahikainen, & Hakkarainen, 2001).

### Self-Regulated Learning

Self-regulated learning theory and constructivist theory complement each other well in fostering learner-centered learning. Self-regulated learning places strong emphasis in cultivating a learner’s ability to be an autonomous learner. Self-regulated learning theory has also provided the theoretical basis in the content design of networked learning environments. Self-regulated learning refers to “learners’ abilities to understand and control their learning environments. Self-regulated learning involves a combination of cognitive strategy, meta-cognitive processing, and motivational beliefs” (Schraw, Kauffman, & Lehman, 2002, p. 1067). In terms of the processes that help individuals to become self-regulated learners, Zimmerman (2001) proposed three phases: the forethought phase, performance phase, and self-reflection phase. The **forethought phase** involves task analysis and self-motivation. The **performance phase** encourages self-control and self-observation. The **self-reflection phase** promotes self-judgment and self-reaction. Research has indicated that learners who proactively set specific goals for their learning tend to pay more attention to their performance and display a higher level of self-efficacy than those who do not set goals (Bandura & Schunk, 1981). It is important to teach students to become self-regulated learners. It is equally important to design learning environments that encourage students to become self-regulated learners. The processes to become self-regulated learners are not through individual effort only. Zimmerman and Schunk (2001) suggested that a social network such as teachers, peer, coaches, or parents can all be part of the processes. Self-regulated learning is especially important in encouraging persistence in networked learning environments when
learners are distributed in different geographical locations. Although self-regulated learners are goal-oriented, independent, and meta-cognitively active in their learning, the complex interaction between computer representations and human factors will influence the choices made in their learning processes.

The implications of self-regulated learning in the instructional design of online learning environments have been discussed extensively (Azevedo, 2005; Kauffman, 2004). Azevedo (2005) suggested that a self-regulated learning framework for the design of hypermedia environments should include:

- Learner characteristics (e.g., prior knowledge, age), hypermedia system features (e.g., access to multiple representations of information, non-linear structure of information), and mediating contextual learning processes (e.g., metacognitive skills, strategy use), and considers how these interact during students’ learning about complex systems. (p. 11)

The research implications of self-regulated learning and HCI have been incorporated into the online learning environment of the APEC Cyber Academy by:

1. Providing online prompts periodically for students to plan and activate their prior knowledge while learning a specific topic.
2. Engaging students in meta-cognitive monitoring activities such as relating the content to what they already know about a topic or verifying with the students that they have achieved certain sub-goals.
3. Providing prompts and feedback if ineffective learning strategies have been used by learners.
4. Including a monitoring system to indicate what goals have been met or not met with a clear time frame.

Azevedo (2005) recommended the use of a human tutor to provide more flexible scaffolding and monitoring for learners in hypermedia environments because of the limited capabilities of the current learning environments. The human tutor serves as an external regulating agent that “monitors, evaluates, and provides feedback regarding a student’s self-regulatory skills” (Azevedo, 2005, p. 14). Azevedo’s research also showed that young learners (middle school and high school) performed better when a human tutor was introduced.

The constructivist and self-regulated learning principles have been the theoretical foundations for the design of learning activities in APEC Cyber Academy. Computer-based agent and human tutors are both included in the facilitation of online collaboration. Learners are able to check their progress and compare their performance against the whole group. The learning modules will be elaborated in the later sections.

**Pedagogical Principles**

While most of the discussion on learning environments have focused on the emerging technologies and effectiveness of the systems, the research on the pedagogical applications of the systems have been scanty (Lakkala et al., 2001). Problem-based learning, reciprocal learning, and cognitive apprenticeship are often cited as some of the pedagogical models that are rooted in cognitive learning theories (Lakkala et al., 2001). Bonk and Reynolds (1997) provided specific examples of pedagogical activities for Web-based learning as summarized in Table 1.

While the system is not a course management system for instructors to store and archive online instructional materials, the APEC Cyber Academy serves as a venue for implementing innovative pedagogy that promotes motivation, creative-thinking, critical thinking, and collaborative learning as outlined by Bonk and Reynolds (1997). For example, the *8 Noun Introductions*
in the Motivational and Ice-Breaking category refers to the use of eight nouns to introduce oneself with an explanation on why the eight nouns are chosen. In the Creative-Thinking Activities category, the Electronic Séances is a synchronous process in which participants have to choose a character from books by famous dead people to participate in a chat to solve a present-day problem. Experts can be invited to participate in the process. Everyone will be debriefed at the end of the activity (Bonk, 2002).

### HCI Principles

A good (HCI) user interface helps to reduce anxiety and fear of computer usage, assist the graceful transition for novice users, provide direct manipulation of objects, offer input devices and online assistance, and allow information exploration through easy navigation (Shneiderman, 1998, pp. 29-30). There have been abundant guidelines written on what constitutes good interface for various computer-based training and learning. Jakob Nielsen (2005) has been a leading figure in usability study. He has observed children’s online behavior and proposed child-friendly design. He compared the difference between age groups and presented the summaries in Table 2.

Children use the Web most often for fun or schoolwork, whereas adults use the Web for business purposes (Bernard, 2003; Gilutz & Nielsen, 2002). Dunham and Sindhvad (2003) summarized usability studies on children’s behavior and concluded the following HCI elements are most important in the design of a kid-centered learning environment:

1. **Animation**: Children are attracted to animations and tend to click on them when available (Bernard, 2003). Gilutz and Nielsen (2002) found that the appropriate use of sound and animation can help children to stay focused on a Web site.

2. **Geographic navigation metaphors & minesweeping**: Children prefer metaphors of geographic representations such as rooms, villages, 3-D maps, or other emulations of real environment for a site entrance. They are willing to engage in minesweeping such
Table 2. Web design approaches for different age groups (Nielsen, 2005)

<table>
<thead>
<tr>
<th></th>
<th>Animation and sound effects</th>
<th>Minesweeping for links</th>
<th>Advertising</th>
<th>Scrolling</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kids</td>
<td>🎈</td>
<td>🎈</td>
<td>🎈</td>
<td>🟥</td>
<td>🟥</td>
</tr>
<tr>
<td>Teens</td>
<td>🟥</td>
<td>🟥</td>
<td>🟥</td>
<td>🟥</td>
<td>🟥</td>
</tr>
<tr>
<td>Adults</td>
<td>🟥</td>
<td>🟥</td>
<td>🟥</td>
<td>🟥</td>
<td>🟥</td>
</tr>
</tbody>
</table>

Key:
- 🎈 Enjoyable, interesting, and appealing, or users can easily adjust to it.
- 😞 Users might appreciate it to some extent, but overuse can be problematic.
- 😞 Users dislike it, do not do it, or find it difficult to operate.

as scrubbing the screen with a mouse to find clickable items or to enjoy a sound effect.

3. **Reading online:** Children are willing to read instructions before starting a game as long as the instruction is kept brief. Children usually do not scroll pages to seek information.

4. **Icons as recognizable symbols:** Children between 8 and 12 prefer icons that represent symbols or languages that they are familiar with from their real environments.

5. **Advertisements:** Children do click on advertisements and think that they are part of the content.

The *APEC Cyber Academy* learning environment is learner-centered and has followed many of the usability guidelines for young learners. The graphic presentations are children-friendly, and the symbols used are as universal as possible to all children. One of the main activities utilizes the metaphors of camping and provides a number of scavenger games for student adventure while engaging in collaborative projects. When students enter the learning space, the navigation buttons are animated with upbeat sound. The content and navigation buttons are accessible within the length of one screen (800 X 600 resolution). The online instructions are all brief and concise. The following sections will provide more detailed information.

**OVERVIEW OF APEC CYBER ACADEMY**

**Objectives**

The main goal of the *APEC Cyber Academy* is to create an international learning environment for K-12 students to interact and collaborate on projects following the principles of social constructivism. The main objectives are: (1) providing a networked learning environment that follows the design principles of human-computer interface to facilitate interaction for learning; (2) utilizing state-of-the-art technology to assist learning and assessment; (3) applying the pedagogical principles of collaborative learning into the design of online activities; (4) fostering international friendship among K-12 learners through online collaboration and computer-mediated communication; and (5) improving ICT skills through project-based learning. To accomplish these goal and objectives, it is essential that the design of the environment can facilitate human-computer interaction and support the pedagogy that is steeped in constructivism and collaborative learning. The
following sections explain how these objectives can be achieved.

**APEC Cyber Academy Components**

Although *APEC Cyber Academy* is much more than a course management system, many of the current course management systems for online learning have functions to support only static presentation of information. The *APEC Cyber Academy* was designed to create a dynamic and interactive learning experience for both instructors and learners. The metaphor of an academy was utilized with the implementation of many advanced computer technologies. The platform includes a lobby, playground, lecture hall, learning space (project-based learning programs), and communication systems that fully support human-computer interaction as indicated in Figure 1.

The *Learning Space* is the place for accessing learning content that includes *Networked Collaborative Learning Program* and *APEC ICT Cyber Camp*. The *APEC e-library* is an electronic library that aims at helping K-12 teachers and students to search appropriate learning resources on the Internet and share instructional materials. The *Lobby* provides a space for building learning community. The *PlayGround* has educational games for fun and entertainment. The *Lecture Hall* allows an instructor to engage students in learning activities through video-conferencing, whiteboard, text/slide presentation, Q&A, quizzes, and learner status. Learners will be able to experience a high level of instructor presence through sound and sight in the *Lecture Hall*. Each unit is designed with specific pedagogical goals as indicated in Table 3.

**Human-Computer Interaction (HCI)**

The system is built to fully support the learner-computer interaction, learner-learner interaction, and learner-context interaction. Learners can find ample online and human support throughout the learning process. Learner-centered support is embedded in the systems under the category of the HCI and communication tools, which consist of various synchronous and asynchronous

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*Figure 1. APEC Cyber Academy components*
interpersonal communication tools as indicated in Table 4.

Building an international learning community and encouraging learners to interact with each other are two of the key principles in *APEC Cyber Academy*. Compared to other educational Web sites, *APEC Cyber Academy* contains rich communication tools such as synchronous text communicator, video conferencing, discussion forums, and learner profile. Learners could use these tools to interact with their international peers. Maintaining a consistent personal identity is the key to success in online interaction. *APEC Cyber Academy* requires learners to maintain and update their personal identities in their profiles. To participate in the activities, a teacher forms a team of students (5-20 students) and enrolls the students in the learning programs. A team member mainly collaborates with teammates to complete the required projects. A participant can also utilize the HCI tools listed in Table 4 to interact with teammates or students from other teams. They can post in the Forum and send mail to each other through the built-in mailbox. They can also observe each other’s progress in the learning programs using the Learner Profile in the WuKong agent. Online tutors also provide learning opportunities through video-conferencing, 3D virtual world chat, or asynchronous tools to interact with learners. Students are encouraged to evaluate projects posted by other teams and provide comments. Through the communication, online support, and assessment systems, human-computer interaction is fully supported.

### Table 3. APEC Cyber Academy components and pedagogical purposes

<table>
<thead>
<tr>
<th>ACA Context</th>
<th>Content</th>
<th>Pedagogical Purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Space</td>
<td>Networked collaborative learning program</td>
<td>Learning activities on holidays, money, a day in school, and convenience stores</td>
</tr>
<tr>
<td>Cyber camp</td>
<td>Learning activities for community building, computer literacy, multimedia development, and language learning</td>
<td></td>
</tr>
<tr>
<td>APEC E-Library</td>
<td>Search engine, repository of learning materials</td>
<td>Databases on learning objects for K-12 instruction</td>
</tr>
<tr>
<td>Lobby</td>
<td>X-File</td>
<td>Motivation, Community building, Fact finding about learning status</td>
</tr>
<tr>
<td>Journalistic kids</td>
<td>Collaboration</td>
<td>Activity report of local communities</td>
</tr>
<tr>
<td>Gallery</td>
<td>Global collaboration</td>
<td>Individual artifacts publishing and sharing</td>
</tr>
<tr>
<td>Forum</td>
<td>Opinion exchange</td>
<td></td>
</tr>
<tr>
<td>Play Ground</td>
<td>Online games</td>
<td>Online recreation, Creative thinking</td>
</tr>
<tr>
<td>Lecture Hall</td>
<td>Slide and text presentation</td>
<td>Information-rich and interactive presentation</td>
</tr>
<tr>
<td>White board</td>
<td>Creative thinking, Brainstorming, Live graphic presentation</td>
<td></td>
</tr>
<tr>
<td>Q &amp; A</td>
<td>Critical thinking</td>
<td>Student feedback and questions about presentation</td>
</tr>
<tr>
<td>Roster list</td>
<td>Online learner management</td>
<td></td>
</tr>
<tr>
<td>Online quiz status</td>
<td>Instant feedback</td>
<td>Pop quiz and summary data collection</td>
</tr>
<tr>
<td>Video chat room</td>
<td>Community building</td>
<td>Instructor and student video with voice</td>
</tr>
</tbody>
</table>
The online postings are monitored by teachers, site managers, and online tutors to avoid possible abuse of the system.

**APEC Cyber Academy System Architecture**

The architecture of *APEC Cyber Academy* system is divided into three layers or tiers—client PCs, Internet Information Server 5.0 and Virtual Worlds Server, and Microsoft Exchange 2000 Server and Microsoft SQL 2000 Server as shown in Figure 2.

The *Internet Information Server* is the Web server that hosts all the digital content and application systems such as e-library, automatic learning activities tracking mechanism, and intelligent agents. Since the learning environment is built on a learner-centered pedagogy, the digital content is rich in interactive functionalities. From a technical perspective, the development of the digital content and the integration of the three-tiered system architecture required heavy coding with Web-based programming technologies such as Microsoft .Net and Component Object Model programming.

The *Virtual Worlds Server* is a 3D multi-user platform that provides immersive learning experiences to learners. The server is a robust, extensive application system. This team project is an ongoing virtual learning research project that uses numerous programming tools.

*A Microsoft Exchange Server* provides groupware services such as discussion forum, mailbox, and video conferencing. The storage of data, such as the learning activities, learner profiles, artifacts submitted by learners, and the e-library repository, are all recorded on an SQL 2000 Server.

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**Table 4. HCI and communication tools of APEC Cyber Academy**

<table>
<thead>
<tr>
<th>Categories</th>
<th>HCI tools</th>
<th>Pedagogical purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>Video chat room</td>
<td>Synchronous communication</td>
</tr>
<tr>
<td></td>
<td>Forum (text)</td>
<td>Module-based asynchronous communication for each learning unit</td>
</tr>
<tr>
<td></td>
<td>Bulletin board</td>
<td>Public announcement</td>
</tr>
<tr>
<td></td>
<td>Mailbox</td>
<td>Correspondence with online learners</td>
</tr>
<tr>
<td></td>
<td>Showcase</td>
<td>Digital portfolio of artifacts</td>
</tr>
<tr>
<td>Online support</td>
<td>Online tutor</td>
<td>Mentor, conference moderation, and forum facilitation</td>
</tr>
<tr>
<td></td>
<td>Learning companion: WuKong agent</td>
<td>Provide scaffolding to learners with voice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show learner profile, notification of new mail, forum posting, hall of fame, buddy list, and help</td>
</tr>
<tr>
<td></td>
<td>Learner profile</td>
<td>Provide information on:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Navigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Ongoing assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Interpersonal communication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Personal information</td>
</tr>
<tr>
<td>Assessment</td>
<td>Peer evaluation</td>
<td>Rubric-based evaluation of artifacts by peer</td>
</tr>
<tr>
<td></td>
<td>Expert evaluation</td>
<td>Criteria-based evaluation of artifacts and learning behaviors by experts</td>
</tr>
<tr>
<td></td>
<td>Interpersonal communication</td>
<td>Online tracking of learner-learner interaction</td>
</tr>
</tbody>
</table>
Pedagogical Applications and HCI Integration

Grounded in the constructivist and self-regulated learning, APEC Cyber Academy has incorporated the pedagogical principles of collaborative learning, project-based learning, creative/critical thinking, community building, and knowledge construction as indicated in Figure 3. The HCI was incorporated into the system to provide effective collaborative learning and project completion. Romiszowski (1981) summarized Bruner’s (1966) theory on three levels of learning: enactive level (direct manipulation), iconic level (visual and mental image process), and symbolic level (manipulation of symbols via language). All three modes dominate one’s learning all through life. Learning activities need to address all three levels to accommodate learner differences. Multimedia network learning environments are especially rich with functions to support all three levels if the activities fully utilize these features.

In APEC Cyber Academy, much of the instructional content is designed for K-12 learners. Students are strongly encouraged to browse and search the learning materials, conduct inquiry-based learning and assess their own learning performance, and communicate among each other in a networked learning environment. The activities of browsing and searching correspond to the enactive level of learning in the learning hierarchy. Ongoing assessment of learning performance such as creating artifacts or reflection activities corresponds to the iconic level of learning. Communicative learning activities such as discussing and consulting with each other among peers correspond to the symbolic or meta-cognitive level of learning (Lin, 2001).

In the design of the learning environment, content cannot be separated from the context. Context refers to the networked learning environment that is enriched with system platform, learning tools, and learning community. The learning content is the learning materials or activities that reside
in the context. E-learning content should not be just about the provision of static information. The presentation of e-learning content in the networked learning environment or context must follow new pedagogical theories and HCI principles, and take advantage of computer network and multimedia technologies. Ideally, the content has to be integrated together with collaborative learning tools and the instructional management mechanism. In other words, the design of learning content and context go hand-in-hand together.

Above all, an e-learning environment should provide self-regulated learning content that allows learners not only to surf the information with their eyes, but also to pursue ongoing assessment and interpersonal communication learning activities meaningfully and purposefully. Also, the consideration of constructivism, sound HCI principles, and the nature of information technology, e-learning content, such as the content included in the APEC Cyber Academy, should focus on the incorporation of three learning activities: navigation, ongoing assessment, and interpersonal communication (Lin, 2001).

Navigation denotes that learners utilize their computers to surf learning resources on the Internet. This is to say that learners use their sense of look and search to obtain semantic knowledge or facts by browsing the information on Internet. It also implies that navigation is a specific learning activity that usually proceeds in a fast pace fashion. Usually, knowledge gained from navigation does not reach long-term memory.

In terms of a learning hierarchy, ongoing assessment is a higher learning activity than navigation is. Ongoing assessment might include each of the following: learners take an online assessment, perform assignments, or create artifacts in learning processes for gaining procedural knowledge and strategic knowledge. Therefore, ongoing assessment usually incorporates learning strategies such as presentation, evaluation, and reflection in assessing or examining learners’ learning performance. The learning activity of ongoing assessment could also help learners to rethink the information they have just navigated and to plan further learning paths and objectives. It is ongoing assessment that really puts knowledge in learners’ long-term memory.

Learning strategies such as discussion, emulation, collaboration, and exchange of ideas among people are related to the interaction of people and all are part of interpersonal communication. This could be the most significant cognitive
activity in the learning processes as learners can construct meta-cognitive knowledge by means of interpersonal communication.

**APEC Cyber Academy Learning Programs**

**International Collaborative Learning Activities**

*APEC Cyber Academy* has hosted an annual nine-week international online contest since 2002. A K-12 teacher who serves as a team leader forms a team of 5-20 students, and they attend the contest through the learning activities in both Networked Collaborative Learning Program and the ICT Cyber Camp. The teacher’s role is to facilitate the learning process, not to complete the tasks for the students. Students collaborate with team members to complete the learning programs, which are described in the following sections. They could be working on projects face-to-face or online. Most teachers use after school hours or connect the activities with curriculum to facilitate students in completing the tasks. The learning programs can be accessed from any networked computers with Web browsers so a student could also login onto the site from home to engage in the collaborative learning process.

*APEC Cyber Academy Awards are presented* to winners of the contest. The winning teams receive recognition from the Taiwan’s Ministry of Education and PCs as the award. This section introduces the learning modules in both programs.

**Participants’ Background**

*APEC Cyber Academy* is a free site for all participants. Registration is required. Users can also enter as a guest with limited access to the site. However, to complete the online contest, a participant should be with a team to have access to certain functions that are essential to complete the learning activities. The participants need to have a basic command of English. Most of the participants are *English as a Second Language* students and view the activities as a great way to improve their English language writing and reading skills. As to the number of registered learners, there are 10,515 (95% of them are fourth grade ~ ninth grade kids) as of the end of 2005. The breakdown of countries and number of participants are shown in Table 5. The country that has the most participants is from Taiwan, and the students are mostly from the public school systems.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Registered Learners</th>
<th>Number of Registered Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>133</td>
<td>Papua New Guinea</td>
</tr>
<tr>
<td>Brunei</td>
<td>87</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Canada</td>
<td>104</td>
<td>Peru</td>
</tr>
<tr>
<td>Chile</td>
<td>37</td>
<td>Philippines</td>
</tr>
<tr>
<td>China</td>
<td>112</td>
<td>Russia</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>47</td>
<td>Singapore</td>
</tr>
<tr>
<td>Indonesia</td>
<td>67</td>
<td>Taiwan</td>
</tr>
<tr>
<td>Japan</td>
<td>90</td>
<td>Thailand</td>
</tr>
<tr>
<td>Korea</td>
<td>438</td>
<td>United States</td>
</tr>
<tr>
<td>Malaysia</td>
<td>285</td>
<td>Viet Nam</td>
</tr>
<tr>
<td>Mexico</td>
<td>10</td>
<td>Others</td>
</tr>
</tbody>
</table>
Networked Collaborative Learning Program

Learning is moving beyond the recall of facts, principles, or procedural knowledge and into the areas of creativity, problem solving, analysis, or evaluation (the very skills needed in the workplace in a knowledge-based economy). Learners need the opportunity to communicate with their peers as well as with their teachers. This of course includes the opportunity to question, challenge, and discuss issues surrounding learners’ daily life. It is claimed by many educators that learning is as much a social as an individual activity. Collaborative learning, constructive learning, and project-based learning seem best suited for fulfilling these needs.

APEC Cyber Academy advocates the project-based learning and learner-centered paradigm strongly. Under the Learning Space, there are four international collaborative online learning projects. The four projects are: Money, Let’s Go to Convenience Stores!, A Day in Our Schools, and Our Holidays as summarized in Table 6. The Web portal of each project has the same structure as outlined in Figure 4.

In collaborative learning, the social context of the learning environment plays an important role. In APEC Cyber Academy, participants of the collaborative learning projects come from different countries with different native languages. In the projects, teachers are expected to provide scaffolding assistance such as offering learning support and guiding the discussion. As for the students,

<table>
<thead>
<tr>
<th>Networked Collaborative Learning Program</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience store</td>
<td>Understand the cultural differences of convenience stores in different countries and currency conversion</td>
</tr>
<tr>
<td>Our holidays</td>
<td>Compare and contrast holidays in different countries thought cross-group collaboration</td>
</tr>
<tr>
<td>Money</td>
<td>Understand the monetary systems and discuss the value of money in APEC member economies</td>
</tr>
<tr>
<td>A day in our school</td>
<td>Enrich cultural diversity through the exchange of schooling experience in different countries</td>
</tr>
</tbody>
</table>

Figure 4. The structure of networked collaborative learning projects
they are supposed to find resources in English, prepare and write their reports for assigned topics in English, use English to communicate with other participants, grade other teams’ artifacts by providing comments in English, and even use video conferencing to talk with participants from other countries. Thus, English learning takes place in a meaningful, authentic context with these pre-designed collaborative learning activities and rich learning communities formed by communication tools. Here, learning becomes a social activity in which teachers, students, and peers work as members of a learning community to gain new experiences and knowledge and solve problems together.

Gallery is a digital portfolio for an individual learner; Showcase is a team or group digital portfolio applied in collaborative learning projects. Figure 5 is a Showcase screen shot that shows an artifact created by one of the participating teams in the collaborative learning program. This figure also shows the comments and grade of peer assessment. Participants and experts can evaluate each other’s project using a checklist with five criteria in the Comment Assistant, which is a grading system for peer and expert evaluation. The system will list all grades that a project receives from peers.

A participant can evaluate a project and check off the criteria that a project has met. A project will receive points from all individuals who have reviewed the project, 5 points as meeting all five criteria and 1 point as meeting one criterion (see Figure 7 for the criteria and description of the Comment Assistant).

ICT Cyber Camp

Camping is a popular activity for most kids, and it could foster exceptional learning experiences that are not provided in classrooms. Virtual camping could be an alternative to the physical camping and create a new experience for all the kids, especially in the context of global education. Perspective campers are free from geographic distance and time zones restrictions, and they can participate in virtual camping activity at any time and from anywhere. In essence, the rationale of virtual camping coincides with the concepts of project-based and collaborative learning perfectly. The ICT Cyber Camp demonstrates innovation by integrating information and communication technology with learning. Therefore, the ICT Cyber Camp will not only provide collaborative learning activities in gaming fashion, but will also guide the school

Figure 5. The Showcase and an artifact submitted by one of the teams participating in the Collaborative Learning Program
learners to explore the wonderland of information and communication technology while they are in the virtual camping site.

It is expected that campers are able to demonstrate the following skills when they pack their belongings and head for home in this nine-week virtual camping activity: (a) Collaborative and global problem-solving; (b) Apply multimedia software to creative development of artifacts, presentations, or written reports; and (c) Communicate with people at a distance and build a global learning community through the Internet.

In essence, the virtual camping focuses on applications of ICT and communication skills, as well as building international learning communities. Although, the program is open to K-12 schools, students and teachers who want to participate must first pass two online computer games before they are authorized to form teams of five including one teacher and four students. The ICT Cyber Camp is composed of a sequence of two online games as the pre-requisite and six correlated learning modules designed with the pedagogical and HCI principles as summarized in Table 7.

**The Prerequisites: APEC Challenger and APEC Traveler**

In the reception booth of the virtual campsite, the perspective participants have to take on two games, APEC Challenger and APEC Traveler, before they are authorized to form teams and join the camp. Both of the games are designed with gaming genres to motivate kids to attain knowledge about APEC member economies and to fit into the English online learning environments.

Based on the quiz pool in information and knowledge about APEC member economies, APEC Challenger pops up questions randomly and allows students to compete with each other.

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**Table 7. Integration of pedagogy and HCI in the ICT Cyber Camp learning modules**

<table>
<thead>
<tr>
<th>ICT CyberCamp Modules</th>
<th>Pedagogy</th>
<th>HCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>APEC Traveler</td>
<td>Interactive games to understand the country names, food, currency, scenery, and national flags</td>
<td>Direct manipulation with arrow keys and mouse clicks, avatar for representation</td>
</tr>
<tr>
<td>APEC Challenger</td>
<td>Co-construction of knowledge and competition on quizzes</td>
<td>Agent base multimedia games</td>
</tr>
<tr>
<td>Magic House</td>
<td>Language comprehension in listening and speaking</td>
<td>Text-to-Speech and Speech-to-Text technologies</td>
</tr>
<tr>
<td>iHunter</td>
<td>Project-based learning</td>
<td>Student produced video presentation</td>
</tr>
<tr>
<td>Story Time</td>
<td>Round-robin activity, collaborative story-telling</td>
<td>Blog-type digital story telling</td>
</tr>
<tr>
<td>Icebreaker</td>
<td>Community building Virtual museum</td>
<td>3D virtual reality</td>
</tr>
<tr>
<td>E-Library</td>
<td>Teacher support and information sharing (refine search skills)</td>
<td>Institute of Electrical and Electronics Engineers Learning Object Metadata (IEEE LOM) Search engines Learning Material Repository</td>
</tr>
<tr>
<td>Campfire Party</td>
<td>Capstone activity Contest progress report</td>
<td>Student-produced video presentation</td>
</tr>
</tbody>
</table>
online as they complete the quiz. The game not only includes multimedia capability in editing and retrieving quiz items and feedback, but also is equipped with computerized assessment functionalities such as instant feedback and scoring. Most importantly, the game provides a sense of a learning community that could enhance and motivate active learning in a global networked learning environment.

APEC Traveler is a mission game that asks campers to complete five missions, which include spelling the names of countries, scenery puzzle, food court, gift shop (currencies exchange), and national flags collection. From the tasks that APEC Traveler provides, perspective campers can learn about the cultures and facts of the different countries, including geographic location, food, clothing, and currency, and so forth.

THE SIX LEARNING MODULES

There are six learning modules that make up the ICT Cyber Camp activities. The six modules are Magic House, Icebreaker, Story Time, iHunter, E-Library, and Campfire Party. All the camping activities are designed for campers to move forward collaboratively in a team, except the module of E-Library. The task in the E-Library module is specifically dedicated to the teacher of the team. The following is an introduction to each learning module:

1. **Magic House**: To guarantee the success of the camping, campers are expected to interact with each other using English. The module of Magic House is designed to help campers develop English capabilities in the aspects of listening comprehension and oral communication. The Magic House is a hotel with 10 floors, and each floor is equipped with different English learning materials that utilize Text-to-Speech and Speech-to-Text technology. Campers have to practice all the learning materials floor by floor and pass the quiz to get the best score possible.

2. **Icebreaker**: The goal of icebreaker is to build an online learning community and inspire interaction among campers in a 3D immersive learning space (Bronack, Riedle, & Tashner, 2005). The module is built on a 3D virtual world where campers are represented with avatars respectively. In the module, campers move their own avatars around the virtual world, which is a virtual world exposition. The module is implemented with the theme of a virtual museum: The Expo 2005. In the museum, campers are asked to appreciate the arts and cultures from different countries. Each team has to send voluntary narrators to introduce the works from their own countries to visitors. In addition, each team has to submit a Web page collaboratively to introduce their new friends made in the virtual museum and the impressiveness of the museum. In the end, campers are encouraged to review the Web pages submitted by other teams and provide grades and comments to the assignments.

3. **Story Time**: The module Story Time is designed following the instructional strategy of storytelling. The primary goal of the module is to excite imagination of campers in ICT applications in the future and to extend the interaction toward cooperation among teams. Digital storytelling is one of the most popular instructional strategies in the context of collaborative learning and language education. Story Time is a chain storytelling session in which the module initiates a scenario that is associated with the application of ICT. For the purposes of effectiveness and better practice, all teams in the camp will be grouped into several communities, each comprising four or five teams. In the module, members of the community will stay around a virtual campfire and take turns telling
stories about how technologies affect the education or daily life in the future. The rule is that any camper in the community can be a storyteller who continues developing the stream of the story following the previous scripts. That is, each camper has to continue his/her story based on the previous story in the community and ensure the consistency of the story.

It is expected that each community will compose a unique set of stories about ICT at the end of the module. Furthermore, all teams have to design four comic pieces of their own to depict the story developed by the affiliated community.

4. **iHunter:** The goal of this module is to investigate and explore how information and communication technology (ICT) is being utilized in campers' local communities or school districts. Technology is changing the ways people do their jobs and changing the traditions of their lives. Campers have to work as a team and investigate how institutes or people in their communities are using ICT in their jobs or daily life and report what they have found in the investigation.

There are two activities for campers to pursue: Best Practice and Interview. In Best Practice, the investigating targets are organizations or institutes such as a school, a class, or even an office in the local community. The chosen target should demonstrate good practice of ICT in its field. In addition to text, it is encouraged to use photos to illustrate the information collected in the investigation. At the end, each team has to put all the information collected in a Web page and upload it to the campsite.

With the Interview, the investigating target here is people instead of organizations or institutes. Each team has to interview a teacher and a student who are using ICT in a unique way in their teaching and learning respectively. It is required to record the interview with a video camera. It is advised to edit the video with software before uploading it to the campsite.

5. **E-Library:** The E-Library system is implemented following the specifications of Learning Object Metadata (LOM) standards provided by the IEEE Learning Technology Standards Committee (2000). The learning module is designed specifically for teachers only. The primary goal of this module is to get teachers involved in the camp and develop skills of searching as well as evaluating online learning materials.

In other words, teachers who are participating in the camp have to surf the Internet and find good quality digital learning content inside their countries and then submit the information about the digital learning content collected through the recommendation system of the APEC E-Library. As such, people in the field of education could share the precious assets of learning materials. It is expected that this collective effort among teachers from different countries could create a rich warehouse of digital learning content.

6. **Campfire Party:** The campfire party is the farewell party for the campers and is held in the final week of the program. Prior to entering the party, each team in the camp has to shoot a short video of their music or art performance such as folk dancing, singing, or cultural illustration, and so on. After the completion of the video editing, every team must upload their video to the campsite and share with all the campers for review and evaluation.

In addition to the farewell party, the module also is the place to check on the status quo of each team in terms of learning performance. Furthermore, the result of the contest of the ICT Cyber Camp program will also be announced in this module. The virtual campsite map is shown in Figure 6.
APEC Cyber Academy Assessment Rubrics

The participants of the Networked Collaborative Learning Program and ICT Cyber Camp are expected to complete all the modules in nine weeks based on the instruction in each module respectively. The performance assessment consists of three categories: peer evaluation on artifacts, expert evaluation on artifacts and learning behaviors, and evaluation on interpersonal interaction.

PEER EVALUATION ON ARTIFACTS

A peer evaluation grading system is embedded in Showcase within some of the modules. All participants are invited to grade or provide comments to all artifacts submitted by other teams. The score of each artifact will automatically be tabulated by the system.

EXPERT EVALUATION ON ARTIFACTS AND LEARNING BEHAVIORS

Several experts are invited to form an evaluation committee and review all the artifacts submitted by each team. The evaluation criteria are based on the artifacts’ quality, creativity, and the timeliness of the submission. Furthermore, the committee will also look into the learning behaviors, including the quality of interpersonal interaction, of each team demonstrated in the contest. Bad and unacceptable learning behaviors could seriously damage the outcome of evaluation.

Automatic Evaluation of Interpersonal Interaction

Building up a versatile international learning community is one of the primary goals of APEC Cyber Academy. Therefore, participants of the
camp are strongly encouraged to interact with their peers, especially with those who are in different teams or from different countries, by using forum and communication tools in the camp.

A tracking system is utilized to sum up the frequency of interpersonal communication automatically for each team. The mark assigned to a team in this category of evaluation will be based on its frequency of interpersonal communication recorded automatically by the learning behavior tracking system.

In short, the mark a team gets at the end of the virtual camping activities is based on its quality and quantity of interactions with other teams, artifacts, learning behaviors, and engagement in the collaborative learning process. The peer evaluation, expert evaluation, and evaluation of interpersonal interaction will count for 20%, 50%, and 30% of the final score respectively.

**Preliminary Evaluation of APEC Cyber Academy**

The underlying strategies in designing the learning content and modules are project-based learning and collaborative learning together with the expectation that HCI principles are incorporated. In this regard, the quantity and quality of interpersonal interaction in the learning processes is the primary indicator to demonstrate the performance of APEC Cyber Academy based on the pedagogical theories of project-based learning and collaborative learning and on HCI standards. In addition, the quantity and quality of interpersonal interaction is believed to be one of the indicators of learners’ active engagement in learning processes (Luca & Mclooughlin, 2004). Furthermore, it is claimed that active engagement in the learning process enhances learning. The claim could lead to two fundamental principles in educational practice: (1) The amount of learning in any activity is directly proportional to the quantity and quality of student involvement; (2) The effectiveness of any learning activity is directly related to the capacity of that activity to increase learning engagement (Barbara, Russell, Gabriel, James, Ronald, & Charles, 2005). These claims support the decision to use the quantity and quality of interpersonal interaction as the primary indicator on evaluation of learning performance in networked learning environments in this preliminary evaluation.

However, in the early phase of the project implementation it was observed that there were few interpersonal interactions (low quantity of interaction), including peer assessment, in the collaborative learning activities. This problem prompted the designers to conduct these two empirical studies with the aim at raising the quantity of interpersonal interaction in its collaborative learning activities.

Two empirical studies had been conducted focusing on evaluations of learning content and context. The first study reviewed the significance of the Comment Assistant in Showcase. The study designed a Comment Assistant for assisting peer assessment. The goals of the study were to examine whether the Comment Assistant could increase the frequency of peer assessment or not and to investigate the significance of the comment assistant on the quality of the peer assessment in networked collaborative learning activities. Figure 7 is the Comment Assistant that is embedded in the “Showcase” section of each networked collaborative learning project.

This study was conducted due to the poor quality and quantity of peer assessment in the APEC 2002 Networked Collaborative Learning Program. The problems were discussed, and solutions were provided by offering a Comment Assistant along with the new interface design of peer assessment modules. The solutions were implemented in the APEC 2003 Networked Collaborative Learning Program. The related data in the collaborative programs of both years were collected with learning activities tracking mechanisms and analyzed with statistical measures (Table 8). The z Test indicates a significant
increase in the mean comments by the participants between 2002 and 2003 (p<0.001). The mean comments by the participants have increased from an average of 12.63 comments per person in 2002 to 18.88 comments per person in 2003. The results of the study revealed that the Comment Assistant has increased the frequency of comments and improved the quality of comments in peer assessment.

The second study focused on the impact of forum structure on interpersonal interactions in networked collaborative learning. The purpose of the study was to increase interpersonal interaction frequency by designing proper forum architecture in the networked collaborative learning environments. Furthermore, the study investigated the impact of forum architecture on interpersonal interactions. The study identified the factors contributing to low interpersonal interactions in APEC 2002 Networked Collaborative Learning Program. Solutions to the problem included a more user-friendly interface and more functions in the forum architecture for the APEC 2003 Networked Collaborative Learning Program.

The study aggregated data on the mean message postings and mean message responses per participant between 2002 and 2003. The z Test has shown a significant increase in the mean number of forum entries from an average of 2 entries per participant in 2002 to 29.76 entries per participant in 2004. The responses have also increased from less than 1 posting per person in

Table 8. z Test of the average of number of comment between 2002 and 2003

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Participants</th>
<th>Mean of Comment</th>
<th>Standard Deviation</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>640</td>
<td>12.63</td>
<td>17.47</td>
<td>-4.26*</td>
</tr>
<tr>
<td>2003</td>
<td>301</td>
<td>18.88</td>
<td>22.49</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001
The increase in postings and responses are both at a significant level (p<0.01) as summarized in Table 9. The significant improvement in forum interaction was due largely to system improvements that provided full text searching, personal information searching, individual performance ranking, online HTML editor, and hot-topic marking mechanism. In addition, the new installation of online facilitators in 2005 has also enabled more flexibility in interacting with the participants through editing capabilities.

Qualitative data such as participant comments that were collected from the forums and online surveys showed that most learners have responded positively in support of the collaborative learning environment. The students who participated in a recent survey have indicated what they liked about APEC Cyber Academy: interacting with participants from different cultures, improving English, gaining new knowledge, engaging in peer learning, and experiencing fun games. There were also suggestions for improvement: providing more interesting games, allowing more time for project completion, giving better instructions on activities, and supplying translation on some part of the Web activities. Although the studies are quite preliminary, we believe that we are in the right direction in the design of content and context for e-learning. More surveys of students’ and teachers’ attitudes toward the activities are underway. The data will yield more insight on the factors that contribute to learner interaction.

The statistical data from these two studies reveals that the quantity of interpersonal interaction has been achieved with the enhancement of communication and learning tools. Whereas, based on the observations of the messages posted in forums and comments provided in the Comment Assistant of peer assessment, the quality of interpersonal interaction is dismal and unacceptable. The messages were neither relevant to learning nor meaningful to social communication. It will be a great challenge in the near future to address the issue of the quality of interpersonal interaction due to its international context and English barrier of its learning community.

**CONCLUSION**

In this chapter, we have provided an overview of the APEC Cyber Academy learning environment and the connection with pedagogy and HCI. We have also elaborated on the specific pedagogical applications such as community building, knowledge construction, project-based learning, problem solving, critical thinking, authentic learning, and assessment that are rooted in constructivist and self-regulated learning. The HCI design including virtual reality, multi-user games, video conferencing, text-to-speech, and intelligent agents are appropriate for young learners. APEC Cyber Academy is flexible and adaptive for learners’ learning needs. Many of the stand-alone features such as the video chat room and
lecture hall are appropriate for both young and adult learners. The environment has also taken into account the diverse cultural backgrounds of the participating learners and encouraged global collaboration. Through the participation in the learning activities, learners are expected to achieve the following goals: (a) work collaboratively and authentically in solving problems; (b) apply computer skills and knowledge in locating information and creating artifacts; (c) communicate in English with international partners, and exchange ideas about global perspectives.

Based on three years of experience in holding international online contests, the design team has also experienced a few HCI issues. First, the system is only accessible from Windows computer using Internet Explorer. This has excluded all Mac users in North American schools, and this is a significant number. That could be one reason that explains the low participation from North America. The primary concern is that teachers and students are not able to participate in the learning programs due to platform incompatibility. Because the system architecture is built on Microsoft .Net and Component Object Model programming, this issue has yet to be resolved. Second, the complicated design can intimidate teachers who are not tech-savvy and reduce the willingness to bring students to participate. More intuitive design and online assistance should be provided to guide participants who need more assistance while navigating through the system. An evaluator who is not part of the design team is currently analyzing feedback from students on attitudes toward different learning programs. The data should provide information on factors contributing to student interaction.

The future plans for APEC Cyber Academy include adding more instructional modules, improving system performance, increasing participants from English-speaking countries, incorporating learning objects such as a learner profile to create the Intelligent Language Tutoring System, and utilizing Automatic Speech Recognition to enhance the communication interface. We believe that APEC Cyber Academy can be the model for the next generation e-learning system.

REFERENCES


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