Title	Transforming teaching and learning through a computer mediated environment
Author(s)	Ang B. S. Daniel and Chen Ai Yen
Source	*ERA-AME-AMIC Joint Conference, Singapore, 4-6 September 2000*
Organised by	Educational Research Association of Singapore (ERAS)

TRANSFORMING TEACHING AND LEARNING THROUGH A COMPUTER MEDIATED ENVIRONMENT

Ang B. S. Daniel & Chen Ai Yen
Nanyang Technological University
National Institute of Education
Singapore

Abstract: This paper reports on an attempt to transform our teaching and learning in schools to prepare our students to not only survive but thrive in the global knowledge-economy of the new millennium. Through integrating technology in the teaching and learning process, the adoption of cooperative learning strategies and inter-disciplinary project work (IPW), some forty students and ten teachers from two Singapore neighbourhood secondary schools were engaged in knowledge building through the *SUCCESS-COMMONTOWN™* projects. The projects were designed to take into consideration lessons learned from the first study, *SUCCESS-ScienceALIVE II*. After eight months of collaboration among students, teachers, researchers, and practitioners, a number of positive outcomes have been observed.

The majority of the students have shown some gains in cognitive and social development. They were able to engage in web-based information processing. At times they even engaged in higher order mental operations including problem solving and metacognition. The teachers were able to make use of the available technologies to adapt their teaching to the needs of the students and their projects. They were flexible enough to use alternative technologies when necessary. However, there were some issues that surfaced, for example, the lack of a consistent mental model among teachers and students in terms of knowledge-building, facilitation, and the use of technological tools. Technical problems of the system also affected the level of cooperation and social learning.

The findings and issues will be discussed to enhance our understanding of using a computer-mediated environment to prepare our students to acquire generic communication and social skills for the global knowledge-based economy.

Introduction

Schools around the world are undergoing major changes to meet the challenges of the new millennium. In Singapore, the Ministry of Education has implemented a number of major initiatives to prepare students for the emerging knowledge-based economy. One of these initiatives is the Masterplan for IT in Education. In the IT Masterplan, information technology (IT) is to be used to enhance the linkages between the school and the world around it so as to expand and enrich the learning environment as well as to develop thinking, learning and communication skills among all learners. IT is also expected to generate innovative processes in education and promote administrative and management excellence in the education system.

This paper reports the experience of a school-based technology-related research project, *SUCCESS-COMMONTOWN™*, which is a part of an R& D project - Strategic Use of Computers for Constructing Effective Studies (**SUCCESS**). The purpose of Project *SUCCESS* is to prepare students to acquire life-long cognitive and social skills and the right mindset for the global knowledge-based economy of the new millennium. Based on the findings and experience on the projects, we make some recommendations in terms of technologies and human resource for supporting the endeavours to transform teaching and learning.

Theoretical framework

The theories that underpinned the *SUCCESS-COMMONTOWN™* projects were the Vygotskian socio-cultural theory (e.g., Vygotsky, 1978), activity theory (Chaiklin and Lave, 1993), principles of cooperation and competition (Johnson and Johnson, 1989; Slavin, 1983), and theories and technologies for knowledge-building such as the Computer-Supported Intentional Learning project (e.g., Scardamalia and Bereiter, 1991), as well as the Cognition and Technology Group at Vandebilt (CTGV, 1995).

Background of Project *SUCCESS-COMMONTOWN™*

SUCCESS-COMMONTOWN™ was initiated in January 2000 as a collaborative project between two Singapore secondary schools: *Bendemeer Secondary School (BSS)* and *Monk's Hill Secondary School (MHSS)*. Some forty students of mixed ability (*Normal Academic, Normal Technical*, and *Express*) and ten teachers participated in the projects. There were four main phases in the projects: (1) Planning and preparation, (2) Intra-group collaborative investigation, (3) Inter-group collaborative investigation, and (4) Sharing and reporting experiences. The phases of the projects were not sequential but iterative because they were interrelated and interconnected.

Phase 1 – Planning and preparation

Three meetings were held with the Principals, teachers, and researchers to brainstorm and formulate the problems, select the students, and plan the action strategies. Two areas of focus and four interdisciplinary project topics were decided: *Technopreneurship – E-education* and *E-commerce* and *Lifestyle – Health and Environment and Fashion and Entertainment*.

A total of fifteen sessions of e-discussions were planned. A common login on every Tuesday and Friday was decided upon, during which students from both schools would communicate and discuss their projects online. In two meetings and two workshops, both school principals reached consensus that their schools should adopt common strategies to acknowledge staff and student contribution and involvement in the project.

To facilitate interaction between the groups in the two schools, a computer-mediated learning environment called "COMMONTOWN™" was introduced. The *COMMONTOWN™* trainers conducted training workshops for the teachers and students on four occasions, two at each school. At the same time, the software was installed in the school computer laboratories.

Figure 1. The SUCCESS-*COMMONTOWN*™ common land

COMMONTOWN™ was designed based on the town concept with the aim of creating online communities. Figure 1 illustrates the main *SUCCESS-COMMONTOWN*™ common land. A suite of communication and collaboration tools was made available: objects, construction tools, navigation tools, navigation tools, communication tools, and application tools. A broadcast channel for posting mass messages to participants was created to allow the teachers to send messages to all the participants. A common discussion forum for project was set up as well.

Phase 2 – Intra-group collaborative investigation

The teacher-in-charge in each school conducted a briefing with the other teachers and students to clarify the scope of the project. The groups discussed and planned the research questions it would seek to answer, with the help of the teacher. Some of the groups decided to conduct a survey while others decided to conduct interviews, and some both. Information was gathered from various sources, such as the WWW, libraries, books, and encyclopaedia. The teacher-facilitator provided students with content materials, directed students to resources, and helped students to design the survey form.

Phase 3 – Inter-group investigation

Inter-group investigations were conducted via the *COMMONTOWN*™ environment. Students from both schools met online every Tuesday and Friday from February to May 2000 to plan action strategies for building the two main "land" and their own individual plots under the supervision of teacher-facilitators and student team leaders. During the inter-group investigations, students made use of the discussion forum and instant message tools to discuss and exchange ideas.

Phase 4 – Sharing and reporting experiences

Students created artefacts and hyperlinks to relevant web sites, which contained information that were useful for the readers. Teacher-facilitators helped students to categorise and organise the information they gathered and also to improve on the design of the plots of 'land'. Students shared and reported their experiences to the principals, teachers, and researchers. The sharing and reporting sessions enabled the principals, teachers, and researchers to evaluate students' progress and provide feedback to the students. In addition, such presentations also allowed the students to reflect on their work and learning experiences. Students made use of presentation software, such as *Powerpoint* and *Presentation Pro* to present their projects.

Data Collection

Notes of meetings, discussion forum logs, observations, and e-mails served as invaluable sources of information for the case studies. Students' sharing and reporting was treated as formative evaluation of the students' work. During the formative evaluations, students were asked questions, such as: (a) How was the collaboration with students from other school?, (b) What were some of the problems faced during the project (technical and collaboration)?, (c) Would they prefer face-to-face collaboration or virtual collaboration? and (d) Would they have preferred a shorter project during the holidays instead of stretching it throughout the year? Students were then provided with feedback from the principals, teachers, and researchers.

Findings

The outcomes of the collaborative Interdisciplinary Project Work (IPW) described in this section were based on the verbal reports made by students during the formative and summative evaluations, observations, notes of meeting and the plots of 'lands' developed by students. These outcomes from project-based learning fall into three categories: student learning, computer-mediated learning system, and teachers' actions and leadership.

1. Student learning

Initially the students had mixed feelings about the project. Some students were worried that they were not able to cope with project work as well as school work. Some students felt stressful, as they had to meet every Tuesday and Friday. However, there were some who were excited because they had the opportunity to learn new computer skills using word processing and presentation software, Internet search engines, and software installation in the process of doing their projects. One student commented:

> We learned new software, *Presentation Pro* which we used for preparing our presentation. (Student)

Students also learned to be disciplined in their work, as they were left very much on their own to make decisions. Some teams reported that the team spirit was high and students were very motivated. Some students indicated that they gathered more idea through brainstorming. One student said the project had stimulated her interest and had prepared her for university.

> I've learned a lot about IT tools. I think I now can dream of going to the university.
>
> (A Normal stream student)

However, students also encountered some problems. Some were overwhelmed by the number of ideas generated and had problem sorting them out. Some of the groups encountered conflicts but were able to resolve these with the help of the teacher. In one team, one of the members, who was not cooperative was removed from the team.

> We told the teacher about her absence from 'meetings', she was left out.
>
> (Student, E-Learning)

Another problem was parental objection to students' participation in the projects. Some of the students had to leave the group because their parents felt that they were spending too much time on the projects, which do not contribute to their examination grade.

Our experience with the *COMMONTOWN™* projects also showed that students of mixed-ability levels were able to learn and construct knowledge with a team. The *Normal Academic* and *Normal Technical* students were able to share their technical skills with the

Express students, while the *Express* students were able to contribute in concept formation. Research has also shown that Normal stream students tend to be less task-oriented (Chen & Mashhadi, 1998; Goh, Chang, and Chen, 1996). In the projects, students regulated each other's progress, ensuring that students were on-task.

2. Computer-mediated learning system

The effectiveness of the computer-mediated learning environment in facilitating students' learning is dependent on the infrastructure and systems and tools.

(a) Infrastructure

The Singapore Ministry of Education has provided a well-conceived and comprehensive Masterplan for IT in Education. This had enabled the two schools, which are in the third phase of the Masterplan to install appropriate technologies for the purpose of the collaborative IPW.

(b) Systems and tools

Students also encountered some technical problems related to computer hardware, the Internet proxy, uploading, password, slow response time, and the network.

> Sometimes we just can't access CommonTown through the MOE network server; you have to wait a long time. Unlike Magix line, it is so much faster. (Student)

As the school kept a master copy of the students' user names and passwords, the password problem was resolved easily.

> Sometimes we lost our password, but fortunately our teacher keep a master copy of the user names and passwords. (Student)

Another problem that students faced was difficulties in synthesising "knowledge" gathered. Face-to-face meetings had to be arranged for them to discuss and select the information to put on the common 'land'. Although the *COMMONTOWN™* systems recorded the student's discussion, teachers and researchers had difficulty in analysing the large volume of text.

3. Teacher's actions and leadership

The importance of teachers' actions and leadership cannot be over-emphasised.

(a) Teachers' actions

One of the key reasons for the success of the *SUCCESS-COMMONTOWN™* projects was teachers' facilitation. Students reported that they had difficulty selecting the relevant information. The teachers guided and coached them in the formulation of project goals and helped them to categorise and synthesise the information gathered. Students were able to design the questionnaires and conduct surveys because of the support provided by the teachers. Students from the Life Style group commented:

> Our teacher made the contact with his friends in Chinese High, NJC and Nanyang Girls and we just went to talk to the students…We also managed to get a letter from our Principal to talk to the students in the other schools…(Students of Life Style Group)

However, most activities took place face-to-face instead of through the *COMMONTOWN™* system. Some teachers preferred to use tested methods and technologies (e.g., face-to-face, telephone, etc.). It is like putting "new wine in old wineskin" (new technologies - "old" ways of instruction). For example, one of the teachers felt that the *COMMONTOWN™* system was a hindrance to the collaboration:

> E-environments are like "new toys" to the students. E-environment was more a hindrance than a help, as students could have met face-to-face or used the telephone because distance was not a problem. (Teacher)

Another argument was that the collaboration between the two schools was "forced", that is, procedures for collaboration were prescribed for students. However, the majority of the teachers felt that it was an innovative way of teaching. One teacher summarised this view:

> Much of what was happening was new – working on projects, working with other schools, and working in an e-environment and with e-tools, therefore it would take time for the students and teachers to adapt. (Teacher)

(b) Leadership

Teachers provided leadership by managing and monitoring students' collaboration in the system and face-to-face. They set time frame for tasks to be accomplished and arranged the necessary facilities for knowledge building on- and off-line. In addition, teachers supported students in sorting out relevant information gathered by the students, and categorising them accordingly. Besides teaching computer skills, teachers also taught the students critical thinking skills so that they could discriminate between useful and irrelevant information.

The two schools' principals encouraged shared vision and provided direction for the implementation of the project. They adopted common management strategies to acknowledge teachers' and students' involvement in the projects.

Discussion

The majority of the students have shown some gains in cognitive and social development. They learned to engage in web-based information processing in addition to gathering data in conventional manners, e.g., through opinion surveys in the form of questionnaires and face-to-face interviews. In their search for information and new knowledge about the topics chosen, they had to engage in higher order mental operations including problem solving and metacognition. The teachers were able to make use of the available technologies to guide the students' learning and used the necessary cognitive and technological tools and environments to improve their projects.

However, there were some issues that surfaced, for example, the lack of a consistent mental model among teachers and students in terms of knowledge-building, facilitation, and the use of technological tools. One of the main purposes of the *SUCCESS-COMMONTOWN™* projects was to allow students to collaborate in knowledge building using the computer-mediated learning environment. However, most of the knowledge building activities occurred off-line. For example, student gathered data through conventional method and analysed and interpreted the data off-line instead of discussing with students from other school using *COMMONTOWN™*.

The lack of online collaboration was partly due to the technical problems encountered, but mainly due to the lack of encouragement from the teachers. Both teachers and students did not feel the need to use the system for collaboration and were more confident and secured using traditional face-to-face educational practices. For example, the teachers guided the students in the designing of the survey questions. Students used the *COMMONTOWN™* system as a platform for displaying their artefacts with hyperlinks to

other web sites. They also made use of other technological tools such as word processing and presentation software.

We discuss some of the pedagogical issues that arose when using a computer-mediated learning environment and proposed some recommendations.

Recommendations

Based on the findings, we proposed some recommendations in terms of improvement to the systems and tools as well as human resource, training requirements, and recognition.

1. Systems and tools

One of the key problems with most computer-mediated learning environments used for online learning are generic communication environments which were not designed specifically for teaching and learning purposes. Such generic environments lack the tools to support teacher's facilitation and students' collaboration. We recommend technologies that will support teachers' facilitation and students' collaboration.

(a) *Technologies for monitoring learning flow*. There were no facilities to enable teachers to monitor the progress of the project except by personally visiting the "lands" or checking with students either face-to-face or via the instant message or forum. Additional monitoring support should be provided. Technologies such as workflow systems can be used to track the "learning flow" of the students. Workflow technologies would allow the teachers to specify to the system activities at each stage of the project and the milestones and the system will prompt the teachers and students when a task is due.

(b) *Technologies for synthesis of knowledge*. To allow the students to build knowledge, the system should provide coherence and support the students' efforts to synthesise "knowledge". Students were building their own "land", but had difficulty synthesising the knowledge on the common "land". Technologies to aid synthesis of knowledge such as the "Knowledge Map" (Hewitt, Scardamalia, and Webb, 1997) should be provided.

(c) *Technologies for structuring conversation*. Communication tools, such as chat and discussion should be equipped with software tools to provide structure to facilitate conversation and reduce information overload. Systems such as the Knowledge Forum (Scardamalia and Bereiter, 1994) provide such a structure.

(d) *Technologies for information extraction*. Currently, it is time consuming to read the discussion forum logs to sieve out the key points of the discussion. Technologies such as information extraction and data mining techniques are useful for such purpose. Information extraction had been successfully implemented in other domains, such as finance (e.g., Wee, Tong, and Lim, 1999).

(e) *Technologies for decision-making*. In collaborative IPW, students need to make decision after they had generated ideas through discussion. Although *COMMONTOWN™* has a "voting" tool, students did not make use of it due to difficulties in using it. Tools to support decision-making, such as group support systems (GSS) are useful for this purpose.

(f) *Technologies for annotation*. Students often make references to artefacts, such as web pages, or objects in the common land. Tools that allow students and teachers to make comments and at the same time reference the artefact will help to improve understanding and progressive discussion.

2. Human resource and training requirements and recognition

(a) *Human resource*. In terms of human resource, technical staffs should be deployed in schools to provided technical support to the teachers and students.

(b) *IT and research training*. IT and research training should be arranged for principals and teachers, as they are important "change agents" in transforming teaching and learning in the knowledge-based economy.

(c) *Recognition*. There should be recognition and support for principals and teachers as leaders in IT implementations.

Conclusion

The *SUCCESS-COMMONTOWN™* experience has shown some gains in computer skills and cognitive and social development in the students, which are essential for the knowledge-based economy. The projects had introduced new instructional resources, new teaching practices, and new technologies. Except for a minority, teachers were able to make use of technologies to adapt their teaching to the needs of the students and their projects.

We have discussed the results, insights, and issues that arose in the *SUCCESS-COMMONTOWN™* projects and made recommendations in terms of technologies and human resources that can further enhance and transform teaching and learning through a computer-mediated learning environment. In particular we argue that generic computer-mediated learning environments that merely integrate a suite of communication and cognitive tools are insufficient for supporting online teaching and learning. Enabling technologies such as information extraction, data mining, workflow, and group support system must be seamlessly integrated into the computer-mediated learning environment to provide the necessary technological infrastructure for transforming teaching and learning for the knowledge-based economy.

Acknowledgement

The project would not be successful without the contributions of the following:

(a) Mrs. Karen Oei and participating teachers and students led by Mrs. Wong, C. P. – Bendemeer Secondary School.

(b) Mrs. Shirley Abdullah and participating teachers and students led by Mrs. Ariff, N. – Monk's Hill Secondary School.

References

Chaiklin, S. & Lave, J. (1993), (eds.). *Understanding practice: Perspectives on activity and context*. Cambridge University Press.

Chen, A.Y. & Mashhadi, A. (1998). Challenges & Issues of Web-based Learning. *Proceedings of 3rd^{h} Global Chinese Conference on Computer and Education, Hong Kong.*

Chen, A. Y. and Ang, D. (2000). Nurturing Future Knowledge Workers in Technology Integrated Learning Environments: the Singapore Experience. *Proceedings of 5th Global Chinese Conference on Computer and Education, Singapore.*

CTGV (1995). From visual word problems to learning communities: Changing conceptions of cognitive research, In McGilly (ed.), *Classroom lessons: Integrating cognitive theory and classroom practice*, pp. 229-270. 2nd Printing, Cambridge, MA: MIT Press/Bradford Books.

Goh, S. C., Chang, A., and Chen, A. Y. (1996). Normal technical students' perception of their classroom environment, Paper presented at the *Joint Conference of the Educational Research Association*, Singapore and the Australian Association of Research in Education, 25-29 November, Singapore.

Hewitt, J., Scardamalia, M. and Webb, J. (1997). Situative design issues for interactive learning environments: The problem of group coherence. Paper presented at the *Annual Meeting of the American Educational Association*, Chicago, March 24, 1997.

Johnson, D. W. & Johnson, R. T., (1989*). Cooperation and competition: Theory and research*, Edina, MN: Interaction Book Company.

Scardamalia, M., Bereiter, C., and Lamon, M. (1994). The CSILE project: Trying to bring the classroom into world 3. Kate McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice*, 201-228. Cambridge, MA: Bradford Books/MIT Press.

Scardamalia, M., and Bereiter, C. (1991). Computer support for knowledge-building communities", *Journal of the Learning Sciences*, 3(3), 265-283.

Slavin, R. *Cooperative learning*, New York: Longman (1983).

Vygotsky, L. (1978). *Mind in society*, Cambridge, MA: Harvard University Press.

Wee, L. K. A., Tan, L. C., Tan, C. L. (1999). A generic information extraction architecture for financial application", *Journal of Expert Systems with Application*, to appear in mid 1999.