Interactive distance learning between Japan and Germany

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Abstract: The authors have investigated methods of interactive distance learning which enable the exchange of vivid images and voices, interactively and in real-time, between two remote classrooms connected via ISDN. We believe that such methods will bolster pupils' desire to learn and nurture their creative potential through presentations and discussions between schools with different cultures and customs. In this paper, we propose a new method of distance learning which is conceived specifically for use in international distance learning. We also attempt to evaluate the results obtained from actual distance learning experiments conducted between Japanese and German elementary schools.

1. INTRODUCTION

We have constructed an environment for interactive distance learning based on multimedia communications, video equipment and computers, prepared lessons and teaching materials suitable for use in such an environment, and conducted studies on an interactive distance learning system which combines these elements. This system we have named a CCV (short for the primary components of computer, communication and visual,) educational system. The aims of a CCV educational system are to enable

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exchanges between mutually unfamiliar pupils at remote sites, and by exposing each group to the reasoning styles and presentations of the creations of the other group, to stimulate the desire to learn and cultivate creative thought.

Based on such aims, we undertook verification experiments on the interactive distance learning system between elementary schools within Japan (Graf and Yokochi 1997; Koizumi, Dasai, Moriya et al. 1997). Interactive distance learning with overseas elementary schools is of great interest from the standpoint of exchanges between different cultures, but a number of problems exist to impede such verification experiments. In addition to language barriers, time differences and problems with communication circuits, there are also such critical issues as co-operation between teachers in designing and preparing lessons. In particular, in light of the practical application and widespread adoption of interactive distance learning, it is desirable that communication circuits should be based on ISDN, which is already a global standard, and should moreover be at 128 kbps, which is more appropriate for transmissions not limited to data.

In this paper, we propose methods for computer and learning support to enable bi-directional real-time distance learning in which a sense of presence or unity is maintained at a communication bandwidth of 128 kbps, together with the verification experiments conducted between an elementary school in Berlin, Germany and an elementary school in Yamanashi prefecture, Japan.

2. METHODOLOGY OF INTERACTIVE DISTANCE LEARNING

2.1 Model of interactive distance learning

Figure 1 shows the model of interactive distance learning based on the CCV educational system. Each classroom consists of not more than 40 pupils and a teacher. Equipment includes audio and video equipment, computers, and large-format screens; these are together referred to as CCV equipment. The audio and video equipment includes cameras to capture images of the classroom and microphones to capture voice signals, which are transmitted to the remote classroom. The computers are used to manage, retrieve and display animations and other teaching materials. The camera images and computer screens are projected onto the large-format screens by

projectors installed in the classrooms; the images are shared between the two classes.

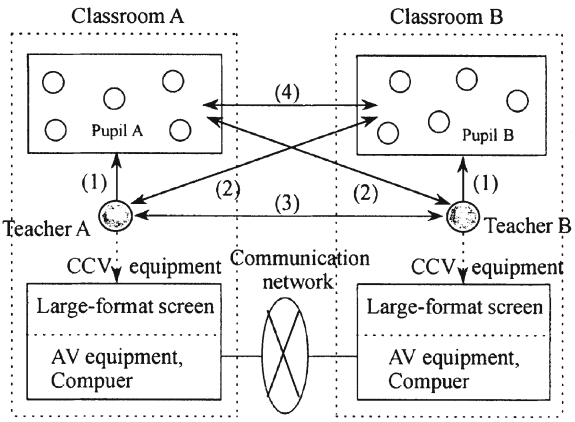

Figure 2. Model of distance learning lessons

In Figure 1, (1) to (4) denote types of interaction in distance learning lessons. Here (1) represents teacher-pupil exchanges within the same classroom (teacher A and pupil A, or teacher B and pupil B); (2) denotes exchanges between a teacher and a pupil in different classrooms (teacher A and pupil B, or teacher B and pupil A); (3) is an exchange between teachers in different classrooms (teacher A and teacher B); and (4) denotes interactions between pupils in different classrooms (pupil A and pupil B). These four types of interaction may occur either individually or in various combinations, according to the lesson content.

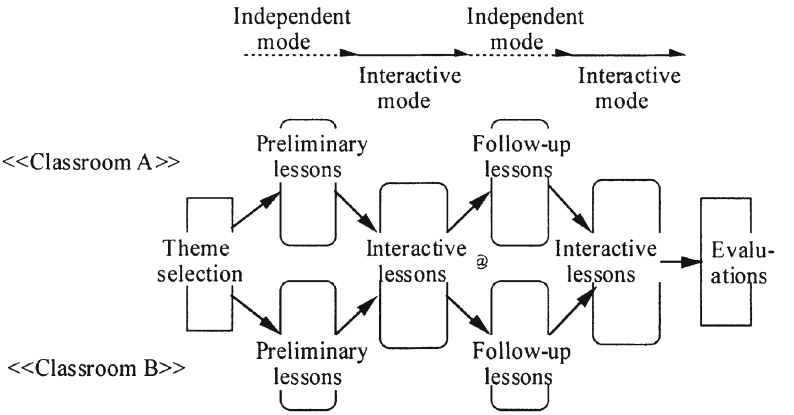

Figure 3. Model of the process of interactive distance learning

The interactive distance learning process is, as indicated in Figure 2, a combination of an interactive mode in which the lesson is conducted with bi-directional communication maintained between the classrooms A and B, and an independent mode, in which studies are conducted independently with no communication between the two sites.

In the interactive distance learning process, first the common problem to be addressed is chosen. This common problem is presented to each of the classes A and B in concrete form, but from different points of view in each case. In preliminary lessons, the problem is solved independently in the classes A and B, and related works are created. At this time, interest in and anticipation of the unfamiliar pupils at the remote site are mingled with the children's lack of confidence in their own solutions, and these amplify their interest in the solution to the problem and spur them to create better works. Interactive lessons of from 60 to 90 minutes are assumed. After the pupils greet each other and introduce themselves, the results of the preliminary lessons are presented and opinions exchanged. At this time children may discover new ideas and techniques they had not thought of before, and this makes them eager to solve the problem or to improve their solutions. In follow-up lessons, the pupils review these new discoveries, and reflect on their own works and problem-solving methods. In the process, their own understanding of and interest in the problem is deepened, and at the same time a sense of competition with the remote-site children spurs them to improve their solutions or creations. As a result, in the next interactive lesson the children can study with a better grasp of the subject matter. Through this teaching procedure the children's desire to learn is stimulated and their creative instincts are encouraged.

2.2 Communication system for distance learning with overseas sites

As means of communication in interactive distance learning, satellite communications or high-speed dedicated circuits may be used to achieve image quality comparable to that of broadcast television (Nemoto, Hamamoto, Suzuki et al. 1997). But in order for bi-directional interactive distance learning to come into widespread use in future, it is desirable that ISDN be used for communication, at a data rate of 128 kbps to hold down communication costs. We propose the following type of communication system for use in interactive distance learning with overseas sites.

1. ISDN circuits at 128 kpbs are adopted for communications. Included in the 128 kbps bandwidth are camera images, audio, images from stand cameras, and computer data.

2. Camera images are images of teachers while teaching and of pupils giving presentations. Computers and stand cameras are used to capture works created by pupils for transmission to the remote-site classroom. Stand cameras are used to capture flat objects; solid or three-dimensional objects are captured using motorised cameras.
3. Audio quality is of prime concern for communication between remote sites. Hence microphones were embedded in the ceiling to clearly capture voices, and 16 kbps of bandwidth was allocated for voice transmissions.

3. CONSTRUCTION OF THE INTERACTIVE LESSONS

Geometry was chosen as the subject for interactive studies; the theme selected for the lessons was 'patterns', because of the chance it afforded to have pupils view images of attractive works and grasp their features. The Japanese class studied the properties of stripe patterns and created works in advance. The patterns themselves were created using computer drawing software, output to a colour printer and then applied to kites, fans and penholders to form completed works. The German class studied the properties of rectangular patterns and composition of motions, and created related works. The German class also used computers to study the features of patterns, and then created works by painting patterns on tiles or postcards.

3.1 Language and time-zone problems

With respect to language problems, it was initially proposed that English be used as a common language; but in view of problems with obtaining accurate translations within the limited time available for interactive lessons, it was decided instead to employ one specialist interpreter at each of the two sites.

The time difference between Germany and Japan is seven hours in summer, eight hours in winter. During summer, 8:00 a.m. in Germany corresponds to 3:00 p.m. in Japan. Taking the circumstances of the children's travel to and from the school, it was decided to hold interactive lessons for 60 minutes, beginning at 8 am in Germany and 3 p.m. in Japan.

3.2 Construction of experimental lessons

The interactive lessons conducted in these experiments will be referred to as DL1, DL2, DL3 and DL4, in the order in which they were held. The relationships between them are illustrated in Figure 3.

In DL1, each class is attended by the teachers and the children. The children first greet each other, and the Japanese children then present works incorporating stripe patterns, while the German children show works which included rectangular patterns. In DL2, only the teachers take part on the German side; the Japanese children present works they had completed as homework, and receive comments and instruction from the German teachers, after which they learn about the approach used in the German class to studying patterns. In DL3, the arrangement is opposite to that of DL2: the German children study the approach to patterns used by the Japanese class. And in DL4, the classes present works which incorporated improvements based on the methods of the other class, and discuss the results. Finally, the two classes discuss future exchanges.

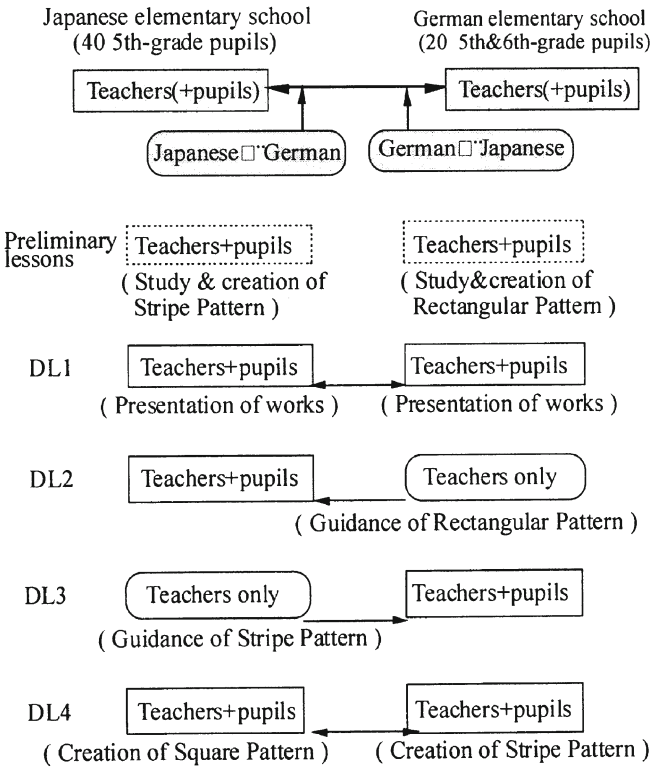

Figure 4. Relation of verification experiments between Japan and Germany

4. EXPERIMENTAL SYSTEM AND RESULTS

Interactive lessons were conducted by two teachers in each classroom, who together taught the lesson and operated the system equipment. Images used in interactive lessons were of two types: images from the TV conferencing system, and computer screen images. Of these, images transmitted via the TV conferencing system consist of images of pupils speaking captured by a motorised camera, scenes of the entire classroom captured by a panoramic camera, enlarged images of pictures and text captured by a stand camera, and video images. These images were shared between the German and Japanese sites via a communication network.

At the Japanese elementary school, these images were projected onto an 80" large-format screen. At the German elementary school, a 42" monitor was used. The communication data rate of the ISDN circuit was 128 kbps, and the H.261 specification was adopted for transmission of TV conferencing images.

4.1 Experiment results

The Japan-Germany interactive distance learning lessons were conducted on the dates indicated below.

a. Prior arrangements
(1) DL1: 17:00-21:00, Sept. 24, 1997(Japanese time)
(2) DL2: 17:00-21:00, Sept. 29, "
(3) DL3: 18:00-20:00, Oct. 20, "
(4) DL4: 17:00-21:00, Nov. 7, "
b. Interactive lessons
(1) DL1: 15:00-16:00, Sept. 25, 1997(Japanese time)
(2) DL2: 15:00-16:00, Sept. 30, "
(3) DL3: 15:00-16:00, Oct. 21, "
(4) DL4: 15:30-16:45, Nov. 10, "
c. Review meetings
(1) DL1: 16:30-17:30, Sept. 25, 1997(Japanese time)
(2) DL2: 16:30-18:45, Sept. 30, "
(3) DL3: 16:30-18:30, Oct. 21, "
(4) DL4: 17:00-18:00, Nov. 10, "

Figure 4 shows some examples of the works presented in DL4 by the German children. Most of the works they presented in DL1 using rectangular patterns were abstract ones. But when they saw the works of stripe patterns created by the Japanese children in DL1, they were interested in various kinds of patterns full of Japanese-like features expressed in them.

They tried to find patterns reflecting German features in their own surroundings. Therefore, their knowledge about the patterns was remarkably increased and their creative potential became heightened. At last, they could create far more complex patterns in their works incorporating their own invention with the knowledge absorbed from the works of the Japanese children. They presented them in DL4. Thus through the mutual stimulation, their works have been considerably improved in quality.

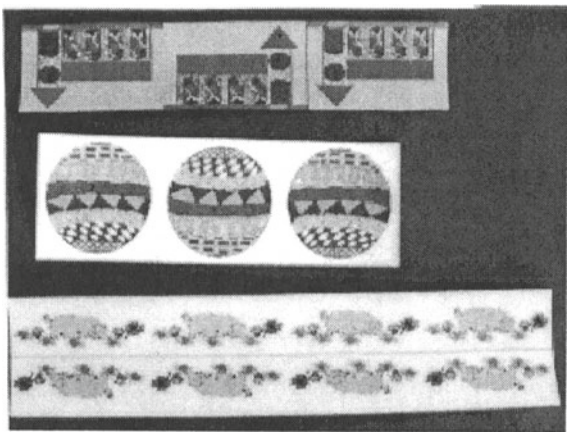

Figure 4. Example of works of German children (Pattern)

5. EVALUATIONS AND DISCUSSION

5.1 Evaluations by the German children

Questionnaires were prepared concerning the desire to learn and attitude of the children during the interactive lessons, the teaching method used, performance of the equipment, and other matters, and the children filled out the questionnaires after each interactive lesson.

The overall evaluation of the lessons was extremely favourable, with pupils agreeing that 'the lesson was enjoyable' and 'I was attached'. Responses to the statement 'I understood everything' indicating depth of understanding of the material was lower for DL4 than for the other lessons. There was insufficient time in DL4 to cover this material in detail. In future it will be necessary to adjust the pace of the lesson to the lesson contents. In response to the statement 'I could follow the lesson' a low score was recorded for DL1 only. This is probably because the German children initially were not accustomed to the lesson format. In response to 'The

lesson was boring', the scores for DL1 were low even compared with the other lessons, indicating that they approached DL1 with great enthusiasm.

The responses to the statements 'The Japanese teachers explained well' and 'Our teachers did a good job of teaching' indicated that teaching by both the Japanese and the German teachers was highly regarded by the children. Team teaching by German and Japanese teachers should be possible. In DL3, the score for 'It was easy to understand the presentations and explanations from Japan' was very high. In this lesson, only the teachers were present at the Japanese site, so this indicates that the learning environment provided by the CCV educational system can be said to satisfy the necessary conditions for distance learning in which pupils are instructed by a teacher at a remote site. The score for 'I wanted more explanations' item was negative, but the absolute value was small. This reflects the fact that the natural opportunities children have in a conventional learning environment to raise their hands and ask questions are limited in distance learning. More time is needed for children in order to become accustomed to freely asking questions of a teacher appearing only on a screen. The items relating to the interpretation, 'I understood the translations well' and 'I was very bored while waiting for translations' elicited favourable responses, indicating that even consecutive translation is sufficient for simultaneous bi-directional distance learning.

Responses for all the lessons disagreed with the statements 'The equipment got in the way of studies' and 'The jerky motions of the images interfered', while responses tended to agree that 'The sound quality was good', thus indicating that the learning environment provided by the CCV educational system did not interfere with studies. A bit rate of 128 kbps seems to have been sufficient as well.

5.2 Evaluations by the Japanese children

Overall the evaluations of the Japanese children were more critical. In particular, the Japanese children wanted more detailed explanations from their German counterparts, and thought that explanations were insufficient. They also felt that the interactive lessons were special types of lessons. With respect to the equipment, they noted that motions were unnatural, and that voices were difficult to understand. There were more children in the Japanese class, and so probably more noise near the children's seats, making it difficult to hear what was said at the remote site.

5.3 The lesson content

In DL4, an attempt was made to have the children study together to solve a single problem. However, the teachers would like to have the pupils present works of their own creation during interactive lessons, so that an excessive amount of time is spent in presenting works. Some innovations are needed here.

Because of the differences in culture, considerable time is required to make arrangements. Some two and a half hours or so were spent making arrangements for each hour of lesson time. Exchanges between the children were affected by the extent of exchanges between the teachers before and after the interactive lesson. The key to lesson progress for the teachers is to place sincere trust in each other. Through a relationship of trust, the timing of the lesson progress, the assignment of roles to different teachers, and other aspects of the lesson go smoothly.

5.4 The communication system

In general, it is not possible to exchange clear images at a transmission rate of 128 kbps. But these experiments demonstrated that if a combination of camera images, stand camera images, and computer data is exchanged as in the present system, the objects of camera shots are limited, and in effect 128 kbps becomes viable. It is also thought that the teachers, pupils and classroom scenes that are captured in camera images are familiar to persons with past experience of interactive lessons, so that such persons will unconsciously tend to augment the quality of the images.

6. CONCLUSION

A teaching method was proposed whereby, through interactive distance learning, the desire to learn of pupils is stimulated and their creative abilities are nurtured. Experiments to verify the proposed method were conducted centred on geometric lessons between elementary school children in Japan and Germany. Exchanges with unfamiliar children were observed to induce a heightened desire to learn and an increase in creative thought, and it was confirmed that the method can be applied to distance learning with overseas sites. However, numerous interesting problems such as the problem of language barriers require further study in order to facilitate intercultural exchanges. We intend to continue our research in this area, building on the results of these verification experiments.

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REFERENCES

Graf, K.D. and Yokochi, K. (1997) Educational experiments of distance learning and reorganisation of mathematics education. In *Proceedings of the IFIP WG3.1 Working Conference,* Villard sur Lan, France 26th-31st October, 1997, 21.1-21.8.

Koizumi, K., Dasai, T. S., Moriya S., et al. (1997) Proposal of an interactive distance learning of CCV educational system and verification experiments. In *Proceedings of the International Conference for Computer Communications* (ICCC'97), 19th-21st November 1997, 107-114.

Nemoto, Y., Hamamoto, N., Suzuki, R., et al. (1997) Construction and utilisation experiment of multimedia education systems using Satellite ETS-V and Internet, *IEICE, Trans.Inf.&Syst.*, E80D(2) 162-169.

BIOGRAPHIES

Hisao Koizumi is a professor of Tokyo Denki. Since 1970, he has been engaged in the research and development of operating systems, software engineering and computer communication system design. He is a member of the Information Processing Society of Japan, the Institute of Electrical Engineers of Japan and Japan Society of Mechanical Engineers.

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Klaus-D. Graf was a research assistant at the University of Illinois and the California Institute of Technology in 1963 becoming assistant professor in cybernetics at the University of Mainz. He became professor in mathematics and mathematics education in 1971, and subsequently in cybernetics, computer science and computer science education at Freie Universitaet Berlin. In 1987 he was visiting professor at the National Central University in Taiwan. He specialises in applications of IT in mathematics and mathematics education, history of computer science, and international and intercultural co-operation. He is an active member of IFIP working groups and ICMI activities.

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