Interaction Characteristics of Student Dyads in Solving Network-Supported Collaborative Tasks

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Abstract

The interaction behavior of student dyads engaging in network-supported collaborative tasks was explored. Four sixth graders (two boys and two girls) from four schools used a network-supported collaborative learning system to perform collaborative tasks. Quantitative and qualitative approaches were applied to collect data concerning the nature of the online students' interaction. The results indicated that online participants showed five types of categories of interaction: device operating, presence confirming, procedure negotiating, activity executing and social contacting. Results also showed the existence of two types of online task-solving modes: a division-of-task mode and a cooperation-of-task mode. The findings have some implications for research and further studies related to the practice of network-supported collaborative learning.

Keywords: collaborative learning, communication mode, interaction behavior, interaction process, online learning

Introduction

Networks can enhance the communication opportunities among learners, support mutual interactions among learners, and help them form a virtual community focused on collaborative learning. Network is considered to be an optimal medium to support collaborative learning activity (Civille, 1990; Din, 1991; Owen, 1993; Resnick, 1992; Riel, 1989; Riel, 1990; Robinson, 1993; Tinker, 1993). There are currently a variety of collaborative learning activities on networks, most of which are associated with scientific activities. For example, the AT&T Learning Network (Gray & Terrie, 1998) and the National Geographic Kids Network (Bradsher & Monica, 1996) have developed some scientifically sound projects.
For a network to be effectively utilized in collaborative learning, the learning activity must be well-designed. Some investigators (Lenk, 1992, Ruopp, Gal, Drayton, & Pfister, 1993, Schifter & Simon, 1991) indicated that a good network-supported collaborative learning activity should provide learners with the opportunity to act as if they were scientists. They also pointed out that a network-supported science project should provide a real-world problem context, plan activity, share information, enhance discussion, and facilitate cooperation.

Learners need communication tools to participate in a network-supported collaborative learning activity. Different communication tools could result in different communication patterns (text-based vs video-based). In addition, different communication patterns could result in different learning characteristics. Harasim (1993) indicated that text-based communication could present opportunities and reactions of deliberation and improve interaction quality. It also could reduce the influence of race, physiological characteristics, age, social background, and gender. Text-based communication could make learners focus on the content of messages, instead of on human biological characteristics (Harasim, 1989, McCreary, 1990). However, some studies found that text-based communication might cause learners to give up the intention of helping their partners because of slow typing skills (Chen, 1999, Wei, 1999). Text-based communication also lacks social contexts (cues) and therefore learners are unable to perceive some delicate, nonverbal messages (such as body language). These weaknesses could affect the extent of interactions among learners (Fulford & Zhang, 1993). Although video-based communication could improve the above-mentioned problems, video cues could also confuse learners. (Locatis, 2000) The huge amount of a video stream might also result in delayed transmission.

Scholars believed that observing the interaction behavior among learners could provide a deeper understanding of the network learning process. Creative thinking usually results from the interactions of discussing and mutual sharing of knowledge (Oliver & Omari, 1998, Riel & Harasim, 1994). Harasim (1991) analyzed postgraduates in an online seminar supported by a text-based system. The findings showed that learners' interaction process was largely related to cognition. Chiu, Huang, and Chang (2000) analyzed in-service teachers and pre-service student teachers' interaction behaviors, their results showed that group performance on concept mapping was significantly correlated to the quantity of group interaction. Lapointe and Gunawardena (2004) examined the relationship between peer interactions and learning outcomes. Their results showed that peer interaction had a strong direct effect on learning outcomes.

Most previous studies have explored the learning effectiveness of collaborative tasks, but few have explored the interaction characteristics during the process of solving online collaborative tasks. In this study, the issue of what communication mode might be preferred and chosen by student dyads during solving online collaborative tasks, the issue of what interaction categories and sub-categories might be presented, the issue of what process patterns might develop, and the issue of what interaction symmetry might be observed were explored. Since few studies have explored the online interaction features of elementary school students, our study explored the online interaction of elementary school's student dyads. To avoid the impacts of slow typing skill in text-based communication and the lack of social cues in video-based communication, both communication modes were provided to the student dyads.
Related studies

1. Elements of network-supported collaborative task activity

Although a student may learn more from a collaborative learning situation than from individual learning, simply grouping students and forcing them to work together does not guarantee that students will achieve above average (Johnson & Johnson, 1990). To achieve good learning effects, collaborative tasks need to be well planned and carefully designed. In addition, learners should have an opportunity to interact mutually and contribute efforts to the group’s productions (Clark & Mayer, 2002).

Lenk (1992) synthesized three successful projects of network science learning: National Geographic Kids Network Project, TERC Star Schools Project, and Reach for the Stars at the Massachusetts Corporation for Educational Telecommunications. He indicated the following elements for designing a network-supported science task-solving activity:

- An activity should focus on real-world issues
- An activity should be a hands-on one
- An activity should involve students in the process of scientific inquiry
- An activity should help students share data, ideas, and results with other students, teachers, parents, and even scientists

Waugh and Levin (1988, 1989) also pointed out that network activity should be combined with classroom activity, should be a cross-regional issue (not just a local one), should be simple and accomplishable in measuring and collecting data, and should be able to allow students to experience the process of scientific inquiry. Some researchers (Lenk, 1992, Ruopp, Gal, Drayton, & Pfister, 1993, Schifter & Simon, 1991) have even suggested that a network collaborative activity should provide opportunities for learners to have an experience similar to that of a scientist, who could go through the processes of data collecting, data analyzing, and data sharing. The project-based activity is the best mode for network collaborative activity. Clark and Mayer (2002) also pointed that an effective collaborative-task could need to develop a project-based process or a structured discussing process.

Chiu, Chen, Wei, and Hu (1999) proposed a stage model to design the network collaborative learning activity. Their stage model includes a preparation stage, a group establishment stage, an assignment understanding stage, a data collection and sharing stage, a data analysis stage, a production preparation stage, a demonstration stage, and a judgment and feedback stage.

2. Communication modes in network collaborative tasks

Learners need tools to communicate, coordinate, discuss and share knowledge and experience in a reciprocal manner. Some scholars have suggested that communication tools which possess a variety of interaction characteristics would be helpful for collaborative learning (Chalfonte, Fish, & Kraut, 1991, Daft, Lengel, & Trevino, 1987). In a collaborative learning activity, in which a learner must work alone
(check and confirm self-tasks), he/she would not need a synchronous communication tool (Locatis, 2000). However, when team members need to make a collective decision, synchronized communication tools become important. Different communication tools would bring different communication modalities, and different communication modalities would result in different interaction characteristics. In the following discussions, we focus our discussions on two communication modes (text-based communication mode and video-based communication mode).

2.1 Text-based communication mode

Researchers have pointed out that text-based communication has some advantage. It can reduce the influence of race, physiological characteristics, age, social background and gender. It allows learners to focus on the content of messages rather than on human physiological characteristics (Harasim, 1989; McCreary, 1990). It usually has a fixed form and can be read repeatedly by a learner (Lebie, Rhoades, & Mcgrath, 1995). It also provides more time for reflection (Garrison, Anderson, & Archer, 1999). However, Gay and Grosz-Ngate (1994) indicated that, in the case of text-based communication, a student needs typing skills, and typing will interrupt task-solving. Learners also need to process text messages (McMahan & Dawson, 1995). Furthermore, text-based communication lacks social contexts (clues). Learners are unable to perceive delicate nonverbal interactions (Fulford & Zhang, 1993).

2.2 Video-based communication mode

Video-based communication has more informal and rich situational clues than text-based communication. Students can simultaneously perform tasks and communicate with their partners. However, it is difficult to read messages repeatedly. The messages are only received and sent at that communication moment. After that moment, learners must rely exclusively on their memory or notes for recalling messages (Lebin, Rhoades, & Mcgrath, 1995). In addition, non-language cues (video cues) may contain messages that could distract the learners' attention from learning (Locatis, 2000).

Gay and Grosz-Ngate (1994) grouped college students into three teams, the three teams were located at three separate locations, and each team took charge of part of a collaborative task. Students used chat rooms, video and audio among the teams. The results showed that students favor video-based communication. However, audio was their main communication channel. Students showed a tendency to use video as a supplement to the audio channel (i.e., watching a speaker via video while using an audio communication channel). Video became a monitoring tool when the members or teams were communicating. Additionally, only when a team member was unable to attract the notice of other teams, the chat room was just used (the chat room has a tinkle, it has reminder function).

Scanlon, Blake, Joiner, and O’shea (2005) were interested in understanding how communication features influenced the problem-solving behavior of participants (including graduate students, researchers, and educational technology developers). They provided three communication modes, audio-only, video-only (an ordinary video connection with audio but not eye contact), and video-tunnel (which provides eye contact), to be chosen by pairs. Their study, which compared the relation of task performance and three different communication modes, indicated that participants who used the
video-tunnel and audio-only communication modes were more successful in their problem-solving. Their study also showed that more negotiating behavior was observed in the video-tunnel group.

3. Characteristics of interaction

Interaction behaviors are regarded as key components in online learning (Gunawardena, Lowe, & Anderson, 1997) Interaction plays a crucial role in knowledge acquisition and cognitive development (Harasim, 1991) Observing interaction behaviors among learners would provide more understanding of the network learning process. In the following section, we describe the category of interaction, the stage model of interaction, the sequence of interaction, and the roles in interaction.

3.1 Category of interaction

Fung (2004) studied online communication in distance learning courses. Sixty students enrolled in an online course. A discussion board, chat room, email, and hyperlinks to useful web sites were provided. The course coordinator and tutors took turns to pose questions on the discussion board to simulate student discussion. Five main categories were identified, namely academic, building relations, support, appreciation, and others.

Harasim (1991) explored postgraduates’ interaction process in an online seminar. That study found that the interaction process was mostly related to cognition, and there were five distinctive categories: knowledge acquisition, elaboration, integration, procedural, and socio-emotional. However, that study also found that only 1% was related to the socio-emotional category.

Some researchers focused their studies on certain special behavior. Webb (1989) described helping behavior in the traditional classroom. Webb classified helping behavior into three categories: explanation-helping, information-helping, and answer-helping. Explanation-helping behavior includes a high-order and detailed interpretation about how to solve problems. It belongs to the high-level type of interaction. Information-helping behavior provides answers to posed questions, and belongs to the lower-level interaction. Direct answering was a non-helping interaction behavior in a collaborative group.

3.2 Stage model of interaction

Roth and Roychoudhury (1992, 1993a, 1994) used a qualitative method to describe the interaction process of collaborative concept mapping in the area of physics for high school students. That study found that, for procuring group consensus, students showed the following process: collaborative construction of propositions (students assured that each one knew what the others meant), adversarial exchanges (students attempted to convince each other), and formation of temporary alliances (two or more students accepted the same proposition, formed by a majority rule).

Smith (2003) explored negotiated interactions among intermediate-level learners of English in a task-based and synchronous computer-mediated environment (ChatNet Internet Relay Chat). Fourteen dyads (age from 19 to 28) participated in that study. Each dyad completed two jigsaw tasks and two decision-making tasks. The results showed that there were several process indicators in the process of...
computer-mediated negotiated interaction trigger, indicator, response, reaction to the response, confirmation, and reconfirmation

3.3 Sequence of interaction

In addition to the above-mentioned studies, some researchers have explored the sequence of interactions. Goldman and Newman (1992) analyzed interaction characteristics between sixth-graders and their teacher. Their communication messages were analyzed on the basis of sequence (initiation-reply-evaluation). The result showed that teacher was the interaction starter in a traditional classroom, but in a network-based context, students might be the starters. Verbal content on a network context was more versatile than that for contents in a traditional classroom.

Some studies also have used the sequence approach to explore the steps of originating, continuing, and ending. VIAS (Verbal Interaction Analysis System) (Ralph, 1990) explored interactions according to the sequence of antecedent - response - consequent. ESA (Exchange Structure Analysis) explored interaction messages based on the sequence of initiate, respond, respond initiate, respond complement and stand alone (Pilkington, Treasure-Jones, & Kneser, 1999).

3.4 Roles in interaction

Chen and Huang (2002) analyzed the content of discussion of ninety-one undergraduates who participated in a network course. The study found that students played three roles in the interaction process: leader, information provider, and conclusion integrator. The leader pushed forward and maintained the entire process of discussion. The information provider provided the related information for discussing issues. The conclusion integrator confirmed, restated and integrated the key points when the discussion was ended.

Jehng (1998) observed undergraduates who were using online communication tools in a psychology course. The results showed multi-thread messages running hither and thither. That study failed to find an obvious opinion leader in the course of the discussion. Ruberg, Moore, and Taylor (1996) had the similar finding to the Jehng's result.

Based on the above-mentioned literature, it is obvious that a network-supported science task-solving should possess some basic elements. It should be a real-world and cross-regional issue, it should be a simple, accomplishable and hands-on tasks, it should involve the process of scientific inquiry, it should be a project-based activity, and it should enhance the interaction among students, teachers, parents, and scientists. For supporting the interaction among online pupils, an online learning system should provide both text-based and video-based communication tools at the same time.

Research Methods

1. Participants

Four sixth graders (two boys, two girls) located at four elementary schools in the southern part of
Taiwan were invited to participate in this study. One student was from a city school, two students were from suburban schools, and one was from a rural school. Students all possess typing and Internet use skills. Their academic performance in the classroom were superior and they had experience in group collaboration, but a lack of experience in network supported collaborative task-solving. They participated in the task-solving activity portion of this study in a computer lab at their schools at noon, four times a week, and one hour per session. The participants knew that observer was there and that they were continuously videotaped while they were engaged in the assigned online activity. The students formed groups voluntarily (they formed dyad groups by themselves). Coincidentally, one group was composed of two girls (Group G, Alice and Ella), and another group was composed of two boys (Group B, Kevin and David).

2. System and its functions

A network-supported collaborative learning system was developed based on a previous study (Chiu, Chen, Wei, & Hu, 1999). That system had the following modules:

- Grouping module. This module provided the functions of grouping students into teams and detecting the online presence of partners. It also allowed members to choose group symbols and create a group name.

- Learning control module. This module provided function of controlling the learning progress.

- Task type module. This module provided function of distinguishing the types of tasks which is the division-task or cooperation-task. This module also provided tools, for example, a co-editing tool.

- Motivation module. This module provided functions of enhancing and maintaining learning motivation and performance.

- Individual contribution module. This module provided an opportunity for individuals to reflect on their contributions to the group. Individual contributions were displayed in the form of a diagram.

- Interaction space module. This module provided a public space and a group space for interaction.

- Communication module. This module provided text-based tools and a video-based tool. Text-based tools include Discussion Area, Chat Room and E-mail. Microsoft NetMeeting was used as the video-based communication tool.

3. Collaborative stages and tasks

3.1 Stage model

This study invited two experienced science teachers to guide our revision of the stage model of our previous study (Chiu, Chen, Wei, and Hu, 1999), and developed a stage model of network-supported scientific task-solving for elementary school students (Figure 1). This stage model...
has seven stages Grouping, Collecting, Analyzing, Discussing, Concluding, Presenting and Evaluating.

<table>
<thead>
<tr>
<th>Grouping</th>
<th>Collecting</th>
<th>Analyzing</th>
<th>Discussing</th>
<th>Concluding</th>
<th>Presenting</th>
<th>Evaluating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Completing group formation</td>
<td>1 Collecting related data</td>
<td>1 Transforming numeral data into suitable graph</td>
<td>1 Discussing &amp; analyzing graph</td>
<td>1 Integrating data and completing final report</td>
<td>1 Publishing productions</td>
<td>1 Evaluating productions of other groups</td>
</tr>
<tr>
<td>2 Discussing and clarifying the purpose of tasks</td>
<td>2 Recording data</td>
<td>2 Observing and analyzing data</td>
<td>2 Discussing related data</td>
<td>2 Checking final report</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: The stage model

### 3.2 Tasks

- Tasks in the grouping stage: Students form groups, fill in group information and recruit partners. During the group formation, members discuss and clarify their target tasks.

- Tasks in the collecting stage: Students search climate-related data concerning rainfall in K city (Kaohsung) and I country (Ilan), and enter the data into a table.

- Tasks in the analyzing stage: Students transform numerical data into graphs (system provides the function of transforming).

- Tasks in the discussing stage: Students discuss the seven facets of rainfall. Those facets include typhoon, the season of the plum rains, landform, air mass and frontal surface, air pressure, season and monsoon. Students read related information provided by the system, or by other online resources.

- Tasks in the concluding stage: Each group produced a scientific report concerning the diversity of rainfall between K city and I county. In this stage, each student takes turns in writing the report.

- Tasks in the presentation stage: Each group publishes a report to the online public space on the system.

- Tasks in the evaluating stage: Each group reads other groups' reports and gives text comments.

### 3.3 Data Collection and Analysis

Data were collected in the summer of 2000 by system tracking, on-site observation, videotaping, and interview. While students were in the process of task-solving, text-based messages (including dialogues and posted messages) were recorded by the system. Non-text data and live state (audio
conversation and body language) were observed and videotaped. Interviews were implemented to further explore some specific issues.

Qualitative and quantitative analysis were applied. Time, text messages, and body movement were extracted from the videotapes. Dialogues were transcribed. The field notes and the data of interview with observers and students were compared. By constantly reviewing and comparing the qualitative data, several themes emerged. The use of communication tools and the interaction categories were calculated by the units of time and frequency.

Findings and Discussions

1. Communication mode preference

Group G and B had a contrary tendency of using communication tools in their task-solving process. Group G tended to use text-based communication. Table 1 shows that students in Group G preferred a chat room (28.5%). In the interviewing, Group G explained that they were unacquainted with their partner, therefore they didn’t want to use video-based tool. The following words came from observers A and B:

Observer A: I asked Ella, why she didn’t want to use the video tool for communicating with her partner? She said that she was embarrassed for talking to partner because she was unfamiliar with Alice.

Observer B: I also asked Alice, why she didn’t want to use the video tool for communicating with her partner? She said that she had no idea for talking what to her partner.

They pointed out that they favored a chat room because of the synchronicity provided by the real time tool.

Table 1: The use of communication tools in Group G

<table>
<thead>
<tr>
<th>task</th>
<th>Collecting</th>
<th>Analyzing</th>
<th>Discussing</th>
<th>Concluding</th>
<th>Presenting and Evaluating</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>second</td>
<td>%</td>
<td>second</td>
<td>%</td>
<td>second</td>
<td>%</td>
</tr>
<tr>
<td>Video and Audio</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>61.2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Email</td>
<td>137</td>
<td>5</td>
<td>14.3</td>
<td>28.5</td>
<td>13.5</td>
<td>0</td>
</tr>
<tr>
<td>Discussion area</td>
<td>0</td>
<td>0</td>
<td>9.2</td>
<td>16</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Chat room</td>
<td>790.5</td>
<td>21</td>
<td>1,298.5</td>
<td>40</td>
<td>975.9</td>
<td>32</td>
</tr>
<tr>
<td>Total (seconds)</td>
<td>3,690</td>
<td>25</td>
<td>3,210</td>
<td>42</td>
<td>3,046</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>3,016</td>
<td>31</td>
<td>2,939</td>
<td>26</td>
<td>15,901</td>
<td>34.7</td>
</tr>
</tbody>
</table>
Group B tended to use video-based communication (27% in Table 2). In the interviewing, Group B explained that voice was a more direct, quick and convenient method than typing, therefore, they preferred to use it. The following conversations came from researcher and two students:

Researcher: Why did you like to use video tool?
David: It’s more convenient than typing.
Kevin: Voice is more direct.

Group G and Group B have just contrary preference in communication tool (pure text-based tools and pure video-based tools), and the preference is kept all the time during the experiment. We also found that, although the students mainly used audio, they also opened the video channel simultaneously. Group B students explained that sometimes audio communication was not sufficiently clear, and that they preferred, at that moment, to switch their attention to the video channel to confirm whether partner was still online or to know what their partners were doing at that moment.

### Table 2: The use of communication tools in Group B

<table>
<thead>
<tr>
<th>tool</th>
<th>Collecting</th>
<th>Analyzing</th>
<th>Discussing</th>
<th>Conclusion</th>
<th>Presenting and Evaluating</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>second</td>
<td>%</td>
<td>second</td>
<td>%</td>
<td>second</td>
<td>%</td>
</tr>
<tr>
<td>Video and Audio</td>
<td>753.5</td>
<td>24</td>
<td>1,162.3</td>
<td>40</td>
<td>1,150.9</td>
<td>40</td>
</tr>
<tr>
<td>Email</td>
<td>69.5</td>
<td>2</td>
<td>7.5</td>
<td>0</td>
<td>21.3</td>
<td>1</td>
</tr>
<tr>
<td>Discussion area</td>
<td>0</td>
<td>0</td>
<td>200</td>
<td>7</td>
<td>822</td>
<td>28</td>
</tr>
<tr>
<td>Chat room</td>
<td>270</td>
<td>9</td>
<td>49.5</td>
<td>2</td>
<td>107.7</td>
<td>4</td>
</tr>
<tr>
<td>Total (seconds)</td>
<td>3,092</td>
<td>35</td>
<td>2,941</td>
<td>49</td>
<td>2,911</td>
<td>73</td>
</tr>
</tbody>
</table>

Table 1 and 2 show that the total time in each stage is quite similar. The similarity was caused by the fixed time interval for online activity in each stage (four times a week, and one hour per time). Tables 1 and 2 show that both groups preferred synchronous communication (Group G preferred a real time chats, and Group B preferred the audio channel). Table 1 and 2 also show that Group B spent 38.7% of the total task-solving time in communication. Group G spent 34.7%. In a network-supported collaborative activity, communication is one of the critical factors for collaboratively solving online tasks. In our study, the total time of two groups’ online communication were less than forty percent of the total activity time. Whether the online communication time is sufficient and helpful for students to engage in online collaborative activity is an interesting issue that should be explored further in the future.

### 2. Interaction Category

By constantly and mutually reviewing, comparing, and referring the audio recordings, text-based
messages, students' body language, observing notes of observers, and data of interview, some themes definitively emerged. Five main categories and twelve subcategories were identified (see Table 3). The definitions and examples of the interaction categories are presented in Table 3. The ratio of interaction categories are presented in Table 4.

<table>
<thead>
<tr>
<th>Interaction category</th>
<th>definition</th>
<th>Examples (dialogues)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main categories</strong></td>
<td><strong>Sub-categories</strong></td>
<td><strong>Device Operating</strong></td>
</tr>
<tr>
<td><strong>Device Operating</strong></td>
<td>Operate devices of network, system, or computer</td>
<td>Hello, Can you hear me? Your microphone has noise My computer just crashed</td>
</tr>
<tr>
<td><strong>Presence Confirming</strong></td>
<td>Confirm whether partner is online</td>
<td>I am online</td>
</tr>
<tr>
<td><strong>Path Confirming</strong></td>
<td>Confirm the current location of information-seeking</td>
<td>Are you in “collection area”? I am in the website of “Central Weather Bureau”</td>
</tr>
<tr>
<td><strong>Signaling</strong></td>
<td>Make sure the partner is still there signal the partner to pay attention</td>
<td>Hello Hey</td>
</tr>
<tr>
<td><strong>Schedule Confirming</strong></td>
<td>Confirm the procedure and activity assigned by the schedule</td>
<td>First search for the information about typhoon, then post them to the “discussion area” I have filled in the data about the I county</td>
</tr>
<tr>
<td><strong>Coordinating</strong></td>
<td>Coordinating, distributing tasks or confering on the best result</td>
<td>Which rainfall data do you want to fill in K city or I county? Use line diagram, OK?</td>
</tr>
<tr>
<td><strong>Directing</strong></td>
<td>Provide guide or direction</td>
<td>Go to “activity guide area” directly</td>
</tr>
<tr>
<td><strong>Helping</strong></td>
<td>Responding to partner's request</td>
<td>Q How do you go there? A from “activity guide area”</td>
</tr>
<tr>
<td><strong>Describing</strong></td>
<td>Using information to narrate something</td>
<td>In July and August, the amount of rainfall between K city and I county is quite different</td>
</tr>
<tr>
<td><strong>Activity Executing</strong></td>
<td><strong>Elaborating</strong></td>
<td>Because it’s the summer season, the South and the North have obvious differences in rainfalls</td>
</tr>
<tr>
<td><strong>Querying</strong></td>
<td>Asking questions related to task-solving activity and conception</td>
<td>In K city, it had maximum rainfalls at August Did it have anything to do with typhoon?</td>
</tr>
<tr>
<td><strong>Arguing</strong></td>
<td>Debating on certain data and related phenomenon</td>
<td>Eh, but, their differences aren’t too large in January, February, March and April Eh, but, in January, February, March and April, the rainfalls at I county are heavier than K city</td>
</tr>
<tr>
<td><strong>Accepting</strong></td>
<td>Supporting or agreeing with opinions</td>
<td>Eh Yes</td>
</tr>
<tr>
<td><strong>Social Contacting</strong></td>
<td>Social interaction unrelated to the assigned tasks</td>
<td>See you tomorrow! May you have a great trip?</td>
</tr>
</tbody>
</table>
Table 4: The statistics of interaction categories

<table>
<thead>
<tr>
<th>Interaction category</th>
<th>message amount (Group G)</th>
<th>message amount (Group B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Operating</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Presence Confirming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Online Confirming</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Path Confirming</td>
<td>16</td>
<td>253</td>
</tr>
<tr>
<td>Signaling</td>
<td>0</td>
<td>391</td>
</tr>
<tr>
<td>Subtotal</td>
<td>16</td>
<td>684</td>
</tr>
</tbody>
</table>

| Procedure Negotiating    |                          |                          |
| Schedule Confirming      | 80                       | 830                      |
| Coordinating             | 49                       | 131                      |
| Directing                | 5                        | 106                      |
| Helping                  | 19                       | 45                       |
| Subtotal                 | 153                      | 1112                     |

| Activity Executing       |                          |                          |
| Describing               | 52                       | 210                      |
| Elaborating              | 51                       | 133                      |
| Querying                 | 6                        | 80                       |
| Arguing                  | 0                        | 39                       |
| Accepting                | 11                       | 151                      |
| Subtotal                 | 120                      | 613                      |

| Social Contacting        | --                       |                          |
|                         | 82                       | 116                      |

| Total                    | 387                      | 3168                     |

Viewing the interactions from the main category perspective, both groups are different in categories of device operating (4% vs 20%), presence confirming (4% vs 22%), activity executing (31% vs 19%), and social contacting (21% vs 4%) Group G had more interaction behaviors of activity executing and social contact than group B. This is similar to the studies reported by Grint (1989) and Zorkoczy (1989) They pointed out that computerized text-based communication had more ardent discussion than face to face, but it also had more off-task messages among the communication messages Group B had more interaction behaviors of device operating and presence confirming than Group G. That was because group B often operated video-based tools and tested two-way communication channels.

Viewing the interactions from the sub-category perspective, Group G and Group B are different in the sub-categories of signaling (0% vs 12%), coordinating (13% vs 4%), describing (13% vs 7%), and elaborating (13% vs 4%) We conclude that the higher percentage of Group G in the sub-categories of coordinating, describing, and elaborating were the result of the use of text-based communication tools. Based on the video recording of Group G, the students not only checked messages but also corrected messages repeatedly before posting them. It seems that Group G students thought carefully and elaborated their messages in a repetitive manner. We conclude that is why group G has more interaction behaviors in the sub-categories of describing and elaborating. This finding is similar to Harasim’s (1993) study, in which she pointed out that text-based communication could enhance the opportunity...
of deliberation and reflection, and improve the quality of interaction. Table 4 also shows that online confirming, signaling and arguing only appeared in Group B. We conclude that their appearances were caused by the usage of the video-based communication tool.

Activity executing is one of the most important online collaborative behaviors and is highly related to collaborative task solving. However, Group G has spent only 31% of their "communication time" in activity executing (note their communication time occupied only 34.7% of their total task-solving time). As indicated in Table 1, Group B has only spent 19%. The issue of how to raise the ratio of activity executing in a network-supported collaborative project for elementary school students constitutes an important issue for future study. Table 4 shows that text-based communication seems to have more behavior of activity executing than video-based communication (31% vs 19%). Whether text-based communication is more helpful for elementary school students than video-based communication should also be explored further in the future.

3. Process Patterns of within-group interactions

Although the two groups went through the same stage model, their respective within-group interaction processes were dissimilar. The within-group interaction sequence of Group G is task dividing, information notification and posting, task checking and integrating. The within-group interaction sequence of Group B is presence confirming, information locations confirming, information discussing and sharing, task completeness checking. Based on our observed data, the two groups have different process patterns of collaboration. Group G has a divide-task pattern and Group B has a whole-task pattern. Their process patterns are illustrated in Figure 2 and Figure 3. Maushak and Ou's study (2007) also found similar collaboration pattern as Group B. Graduate students used instant messenger (IM) to discuss their group projects, students didn't split the task, work individually on their own part, but they worked together instead.

![Figure 2: Divide-task collaborative pattern (Group G)](image1)

![Figure 3: Whole-task collaborative pattern (Group B)](image2)

3.1 Divide-task collaborative pattern

Figure 2 shows that Group G divided the assigned task A into separate parts \(a_1, a_n\). Text-based communication mode might be one of the main factors that cause them to adopt the divide-task pattern. Since Group G members needed to pay attention to keyboarding and keyboarding is a sequential activity, which might prevent members from discussing online task concurrently. Group G developed
the following interaction process task dividing, information notification and posting, task checking and integrating. The steps in the interaction process were exemplified in the following statements (Note the following students’ dialogues were translated from Chinese)

* Task dividing

In task dividing, students negotiated and divided task into subtasks (divide the task A into sub-tasks $a_1, a_2, \ldots, a_n$) The following dialogue is an example of task dividing

Ella About task of explaining the rainfalls, you do the task of K city and I will do the task of I county, ok?

Alice Ok!

Alice In the K city, where has more rainfalls in summer, but less in winter The yearly rainfalls increment in summer and decrement in winter

Ella In the I county, where has more rainfalls in winter, but less in spring The yearly rainfalls increment in spring and decrement in winter

Here is another example of task dividing

Ella First, we complete our own reports respectively and then mail the reports to each other for revision, OK?

Alice Are you saying that we write report individually and we find a time to get online to compare them?

Ella That is right!

* Information notification and posting

After task dividing, Group G members showed the behavior of individual information-posting without information-exchange. The following dialogue is an example of information notification and posting

Ella Typhoon is formed by certain forms of turbulence You can find related information in the “typhoon data area” (information notification)

Ella Typhoon usually raid us in July, August, and September And the southwest part is usually hit hard and cause heavy damage The location of K city is at southwest part (information posted)

Alice Ella, please take a look at the title “typhoon” which I posted a while ago

(The message posted by Alice were The formation of typhoon must be at higher temperature Because of the higher temperature moisture is soon evaporating, then form air whirlpool If it doesn’t be blown away by a strong wind, the air whirlpool would get stronger and finally form a typhoon, then,
bring heavy rainfalls) (information posted)

Ella But it is strange, typhoon often reach H county (Hualien) and I county over the years (Ella still immersed in posting self-information and felt that message was strange)

Ella I don’t see it!

Alice Go to “opinion exchange area”, push down “discuss message” again

Ella I see it! Because typhoon comes here, which will bring cloudburst, then it will has more rainfalls. It is why K city have more rainfalls at July, August, and September (Ella didn’t reply to Alice’s messages, just posted another message)

**Task checking and task integrating**

After information notification and posting, the Group G students checked to see if the scheduled tasks had been completed. Finally, they combined the subtasks into a whole task. According to our observed data, we found that their final combination was not a well-calibrated integration. For example, when one student was writing a report, another student was searching for some data from the discussion area and was attempting to provide some help. However, from the recorded video, we found that the report-writing student did not pay much attention to the offer from the partner. By reviewing the final report, we found that the report-writing student did not include partner’s suggestions into the report.

### 3.2 Whole-task collaborative pattern

Figure 3 shows that the Group B students engaged in all assigned tasks together. Video-based communication mode might be one of the main factors for their adoption of the whole-task approach. Because of the character of the video-based communication, students could easily focus their attention on the same data or tasks and share information simultaneously. Students might therefore not need to divide their task before starting their tasks. Group B showed the following interaction processes: presence confirming, information locations confirming, information discussing and sharing, and task-completeness checking. The steps in the interaction process were exemplified in the following statements.

**Presence confirming**

In presence confirming, students used the chat room to confirm whether their partner was online, if the partner was online, they would open and test the video channel, and then began to engage in the assigned activity. The following dialogue is an example of presence confirming:

David Are you online? (chat room)

Kevin Yes, I am online (chat room)

David Let us open the video-based communication tool now (chat room)

David Hello! (video-based communication tool)
Kevin Hello!
David I can't see you
Kevin You can't see me?
David mm'
Kevin Wait a moment! (adjusting the video device)
David Ok!
Kevin Can you see me now?
David Yes, I can
Kevin Are we going to discuss the analytic diagram of rainfalls today? (begin the activity)

• Information locations confirming

After presence confirming, Group B members began to confirm the location of the related information. The following dialogue is an example of information locations confirming.

David Look at that information, which is about “the effect of typhoon disaster in Taiwan” (a typhoon information location)
Kevin Which disaster? This one?
David Yes!
Kevin Are you sure this is the location about typhoon disaster in Taiwan? (confirming the information)
David That is right!

• Information discussing and sharing

After information location confirming, Group B members began to discuss and share information. The following dialogue is an example of information discussing.

David How do you think of the variation of yearly rainfall in K city?
Kevin In January (pause a while), from February, it has more and more rainfalls, and July has the most rainfalls, and then rainfalls decrease in December.
David It has a “low-high-low” trend.
Kevin It is right.
Here is an example of information sharing:
David Come back to Figure 5! (An air pressure image)
Kevin mm', ok!
Kevin  I am watching it!
David  Take a look at that image in ripe stage
Kevin  Ye, I am watching it!
David  Cold air flows toward warm air, and then the warm air is pushed up! (explaining the image)
Kevin  Right!
David  Then, you see, it has a warm air image, which connected above, the warm air is
     (--some online confirming--)
David  Do you see the above image?
Kevin  mm
David  Warm air is running toward outside, and then the cold air is turning toward inside!
Kevin  mm, the cold air replenish here
David  mm! so, this is low pressure, Does it cause the lower temperature in that area?
Kevin  Yes, it does

· *Task-completeness checking*

After information discussing and sharing, students checked whether the tasks were completed The following dialogue is an example of task-completeness checking

David  The task seems completed today
Kevin  mm, so, that’s the end of today’s work!
David  Yes
Kevin  Are we leaving?
David  Yes  We have completed the scheduled tasks today
Kevin  mm, are you sure?
David  Yes
Kevin  OK!

Group G and Group B displayed different patterns of collaboration Group G students firstly divided tasks into subtasks, worked independently on the divided subtasks, and finally combined individual results into a whole report Group B students regarded a task as a whole and solved a task together
4. Interaction Symmetry

Roth (1995) defined five types of interaction: symmetric interaction, asymmetric interaction, shifting symmetric interaction, parallel occasional interaction, and no participation. We attempted to determine whether the two groups have the phenomena of interaction symmetry within each group. We counted the frequency of discussion behavior (initiating, exchanging, and replying) for each student during their discussion of plum rains and landform. Table 5 shows that the frequency of Ella’s discussion behavior is almost equal to Alice’s. Group G has a symmetrical interaction.

<table>
<thead>
<tr>
<th>Table 5: The frequency of discussion behavior for students</th>
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<tr>
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<tr>
<td></td>
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<tr>
<td>Initiating</td>
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<tr>
<td>Exchanging</td>
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<tr>
<td>Replying</td>
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</table>

Table 5 shows that David was dominating their discussion in the behavior of initiating (9 times), and exchanging (25 times) during their discussion of plum rains and landform. Group B has an asymmetric interaction. The following dialogue is an example of asymmetric interactions:

David: How does air pressure affect rainfall? (initiating)

Kevin: air pressure

David: Because of the low air pressure, vapors move toward the center. Is that correct?

Kevin: It is right! (replying)

David: So, it will bring more vapors

Kevin: Yes! (replying)

David: How about the air mass? (initiating)

Kevin: air mass

David: Because of the air mass comes from the ocean, it has more vapors, and then it would affect the rainfall

Conclusions

This study explored the interaction behavior of elementary student dyads during their solving of assigned online tasks. One group preferred text-based communication, while the other group preferred
video-based communication. Based on our findings, communication modes have some impact on the interaction categories and the patterns of task division. We identified five main interaction categories and twelve interaction subcategories. Those categories and subcategories might be applied to further explore student triads' interaction. We also indicated two different patterns of task division, the divide-task pattern and the whole-task pattern. The symmetry and asymmetry of interaction were also revealed by a short example. Irrespective of the communication mode (text mode, audio mode, video mode) student dyads use, they seem to prefer synchronous communication. This message implies that a network learning project for elementary students would be advised to provide synchronous communication tools.

Owing to participants' academic performance are superior in this study, whether general pupils have the same interaction behavior? Are video clues helpful in making student interact better? What are the communication mode preference, the interaction categories, and the interaction symmetry in student triads? What is the appropriate amount of communication time for solving online collaborative tasks? These issues will clearly require further exploration.
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摘要

本研究旨在探討國小學童進行網路合作任務時其互動行為之特性。研究使用以質為主，以量為輔的方式分析四位跨地區參與合作任務的六年級學童其線上互動的狀況。結果發現，在互動行為類型上可歸類出五大類及十二個細目（「設備操作」、「同步確認」、「程序協商」、「活動執行」、及「社交」），另外，也發現有兩種進行任務的合作模式；此外，小組的互動對稱性也有所不同。文末並提出對網路支援合作學習在研究及應用上的建議。

關鍵字：合作學習、溝通模式、互動行為、互動過程、線上學習