

Scaffolding Facilitates Inter-School Collaborative Learning: A Case Study in China

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Abstract: *Inter-school collaborative learning (ICL) has significant meaning for bridging the educational gap between urban and rural schools. This study examines the effectiveness of three scaffolding conditions on learning outcomes in an ICL environment. One urban primary school and one rural school were selected to participate in the inter-school collaboration. Three 6th grade classes in each school were randomly assigned to one of three scaffolding conditions: lowest-coercion scaffolding (class A), highest-coercion scaffolding (class B), or adaptive scaffolding (class C). Detailed scaffolds were designed and developed to support ICL from 8 dimensions, including 18 strategies and 27 scaffolding tools. Both process data and summative data were collected to measure the learning outcomes at both group and individual levels. Results showed that pupils with highest-coercion or adaptive scaffoldings (in class B and class C) performed better than those with lowest-coercion scaffolding (in class A). Questionnaire results also supported the effectiveness of scaffolds on inter-school collaborative learning. Findings also revealed that middle-coercion adaptive scaffolding was significantly most supportive for urban school while highest-coercion scaffolding was most suitable for rural school.*

Keywords: collaborative learning, scaffolding, strategy, inter-school

1. Introduction

Ever since 2000, the China government launched the ICT (Information & Communication Technology) education in primary and secondary schools. According to the MOE, ICT Education should be offered in all the high schools by 2001, in all junior schools by 2005, and in all the primary schools by 2010 (MOE, 2001). By the end of 2008, 67.5% primary and secondary schools in China have offered ICT Education and each school has 1.5 ICT teachers on average (Zhu, 2011). However, the educational gap and digital divide still exist between urban and rural schools. Studies show that students' general ICT skills in China are rather low

(Cheng, Liu & Huang, 2010; Huang & Dong, 2010), and that although all of urban students and most of rural students have learned basic computer operation skills, urban students' ICT skills are significantly higher than rural students' (Cheng, Liu & Huang, 2010; Huang & Dong, 2010; Lv, 2011; Yang *et al.* 2012). Research suggests that problem solving with ICT, especially in other subjects education, would be a good solution for improving students' ICT skills (Huang & Dong, 2010; Lv, 2011). Therefore, in the plan for 2011 to 2020, the China Ministry of Education has placed great emphasis on bridging the digital divide and 'advocates online inter-school collaborative learning and to improve ICT-

enhance teaching' by encouraging students to conduct collaborative learning through ICT (MOE, 2012).

Collaborative learning has been widely recognized as a significant educational paradigm for its promotion of student achievement and collaborative skills (Slavin, 1995; Thousand, 1994). As a special form of collaborative learning, inter-collaborative learning (ICL) is collaborative learning between different schools and classes, based on the Internet, which not only promote student achievement and collaborative skills, but also improves their ICT (Information & Communication Technology) skills. Most importantly, ICL may provide a 'window' for students, especially rural students, to better know and communicate with peers in other schools. Therefore, ICL has been paid more and more attention in China because of its role in bridging the urban schools and rural schools.

However, as one of the most complicated models of applying information technology for class teaching, ICL is difficult to implement practically (Berenfield, 1996). Just as collaborative learning would not necessarily happen if it was not well-designed and organized (Dillenbourge, 2002), neither would inter-school collaborative learning. Students need aids on what to do, how to form a group, how to collaborate, how to make products, and so on. A further challenge for ICL is that because there may be great gap between rural and urban students in the aspects of collaborative abilities and ICT skills, they may need different intensities or coercions of scaffolds. This means that scaffolds with different development levels should be provided separately for rural and urban schools to provide different degrees of freedom for teachers and students. Although there are many studies on scaffolds in different learning contexts (Chen & Bradshaw,

2007; Dabbagh & Kitsantas, 2005; Kim & Hannafin, 2011; Lu et al., 2010; Van de Pol et al, 2010; Wang & Hannafin, 2009), there is little research on scaffolds for inter-school collaborative learning. Furthermore, just as Van de Pol (2010) indicates that only a small number of effectiveness studies are available, there are even fewer studies that examine the different coercion degrees of scaffolds for ICL. Azevedo (2004; 2005; 2007; 2011) has made consistent experimental studies on the effectiveness of scaffolds with different development levels for self-regulated learning, which come to the conclusion that adaptive process scaffolding is best. However, is this finding also suitable for scaffolding in an ICL environment? Is this finding also applicable to China where the great gap lies between rural and urban schools? This study examines the effectiveness of scaffolds with different intensity levels in an ICL environment.

1.1. Theoretical Framework: Scaffolds for ICL

Research on scaffold design in different learning environments mainly focuses the following questions: which types of scaffolds are needed, what to scaffold, when to scaffold, how to scaffold, and who to scaffold (Azevedo & Hadwin, 2005; Azevedo & Jacobson, 2007). The Scaffold Design Model for ICL was used in this study as the theoretical framework for scaffold design. This model was proposed by Feng and Chen (2011). Feng and Chen's model tries to answer four questions on scaffold design in an ICL environment: what types of scaffolds are needed for ICL, what to scaffold, when to scaffold, and how to scaffold. In this model, eight types of scaffolds in ICL environment are recognized including: Goal scaffold, Content scaffold, Group scaffold, Interaction scaffold, Data scaffold, Outcome Scaffold, Evaluation Scaffold, and Organization Scaffold. Some typical strategies and tools are also recognized to implement each type of scaffolds, as explained in Table 1.

*Scaffolding Facilitates Inter-School Collaborative
Learning: A Case Study in China*

Table 1. Scaffold Design Framework for ICL (Feng & Chen, 2011)

Scaffold type	What to scaffold	When to scaffold	How to scaffold (Typical strategies)
Goal scaffold	Goal orientation	Beginning of each stage	Interpreting common goals Seeking unity of conceptual understanding
Content scaffold	Content direction	The whole process	Structured presenting activity content Offering clear schedule Guiding by different roles
Group scaffold	Group building	Initial stage of each group	Forming a group Ice-breaking Establishing common identity Making common rules Making clear responsibilities
Interaction scaffold	Peer interaction	The whole interaction process	Explanation Argument Raising questions Problem solving Sharing and communication
Data scaffold	Data collection & process	Problem-solving process	Preparing for methods Making plans Process recording Data analysis Multimedia processing
Outcome scaffold	Design, production & distribution of group works	The forming process of group works	Designing of works Producing and distributing
Evaluation scaffold	Evaluation & motivation	at the beginning & end	Making clear evaluation standards Reflection Establishing reward systems E-portfolio
Organization scaffold	Policy and organizational guarantee	The whole process, but especially at the early beginning	Forming unions of school principals Optimizing the organizational structure Seeking policy support

1.2. The Role of ICL

Studies show that inter-school collaborative learning (ICL) has been proved to have significant benefits for students, teachers, and schools (Atkinson etc., 2007).

This study only examines ICL's benefits for students. Atkinson and colleagues (2007) summarized four main categories of benefits for students: enhanced educational experiences, increased attainment, interaction with students from other schools, and

improved transition to secondary school. Besides these, through collaborative learning and especially collaboration with students from other schools, students can improve their collaboration ability through ICL. Because ICL has to be conducted through the Internet and is closely integrated with ICT technologies, students may also benefit from ICL on their ICT skills. Thus, scaffolds in an ICL environment should support students to make achievements on educational experiences, learning attainment, collaborative ability and ICT skills.

1.3. Research Questions

This study aims to examine the effectiveness of scaffolds for ICL, and the effectiveness of different intensity of scaffolds. The research questions are:

- 1) Do the scaffolds support ICL effectively?
- 2) How do the teachers and students evaluate these scaffolds and strategies?
- 3) Which intensity level of scaffolds supports best?

Dillenbourg's (2002) theoretical framework of intensity levels of CL scripts was adopted to define the different intensity levels of scaffolds in this study. Dillenbourg (2002) emphasized five levels of coercion degrees of CL scripts: induced scripts, instructed scripts, trained scripts, prompted scripts, and follow-me scripts. The coercion degrees of the five levels vary from low to high. Induced scripts have the lowest degree of coercion 'but often not sufficient to significantly influence the collaborative processes' (Dillenbourg, 2002). Hence, in this study, 'Instructed Scripts' was adopted for the low-coercion scaffolding condition, and 'Follow-me Scripts' was adopted for the highest-coercion scaffolding condition.

2. Methodology

2.1. Research Methods

An experimental study was conducted to examine the effectiveness of scaffolds with different intensities. An urban primary school and a rural primary school were selected to participate in the ICL project. None of the teachers and students in the two schools had ICL experience that help to examine whether the scaffolds and supporting tools can support the ICL successfully or not. During the process of the ICL project, three classes in each school were randomly assigned to one of three conditions: lowest-intensity scaffolding, highest-intensity scaffolding, and adaptive scaffolding.

Class A (lowest-intensity scaffolding group): Students carry out their ICL with the lowest intensity scaffolding. Students were presented with the ICL theme, task, instructed scripts, and evaluation criteria. No further teacher intervention was supplied during the course of ICL. Students had the most freedom on the choice of teammates, group forming, interaction with peers, data collection and process, product making, etc. The instructions for teachers in the NS class are: 'You are the teacher of Class A. Class A is designed to inspect students' own ability to complete the task with the lowest intensity of scaffolding and the absence of teachers' intervention, so please let them complete their tasks by themselves.'

Class B (highest-intensity scaffolding group): Students are presented with the task, follow-me scripts, and the most detailed scaffolds. Students were asked to complete the ICL following the scripts strictly and using all the scaffolds and tools. During the course of the ICL, teachers provide students with the highest degree of intervention, with all the scaffolds and tools strictly following the design. The instructions for teacher in Class B

are: ‘you are the teacher of Class B. Class B is designed to verify the effectiveness of the ICL’s scaffolds, strategies, and tools developed by the research team. In order to ensure the reliability and validity of the findings, please organize the ICL strictly as program B, please do not decrease or increase any scaffold, activity, or tool.’

Class C (Adaptive scaffolding group): Teachers in Class C are provided with all the scaffolds and some optional strategies. He/she can judge and select appropriate scaffolds, strategies, and tools for his/her students flexibly, or even make some modifications, according to his/her students’ levels and performance. The instructions for teacher of Class C are: ‘You are the teacher of Class C. Class C is designed to let you judge and use the strategies and tools flexibly. We have provided detailed steps of activity, strategies, and tools for you. During the ICL, you can select, revise, add, and delete the scaffolds and tools according to students’ levels and performance. A set of optional strategies is provided for you with reference in appendix 2. Please record all your modifications and selections of strategies and tools.’

2.2. Participants

Two schools were selected to conduct the inter-school collaboration. One is an urban key school located in a city, and the other is a rural school located in a remote mountain. Two-hundred and seventy 6th grade students from six classes in the schools engaged in the inter-school collaboration, with the guidance of nine teachers. None of the teachers and students in two schools had ever had any experience or knowledge of ICL. The three classes and teachers in each school were carefully selected to be at the same level. All of the teachers are in mid-thirties and experienced. Their ages range from 30 to 38, with 8 to 16 years of teaching experience.

2.3. Design of the ICL Project

An ICL project was designed and conducted between two schools. The theme of the ICL project was ‘Lovely Hometown—I’m the little guide,’ integrated with the Chinese Subject. There is a unit ‘My hometown’ in the Chinese Subject of Grade 6, with the learning purposes to improve the knowledge about hometowns, and to develop skills on writing and speech. In the ICL project, students were required to investigate and collect data about their hometown, and to design and introduce their hometown as a virtual guide to students in the other school. The learning outcomes of the ICL project include: 1) to expand knowledge of their hometown and the other city/countryside, 2) to develop skills on writing and oral speech, 3) to develop skills on investigation, including data collection and data process, 4) to develop collaboration ability, 5) to develop ICT skills including online communication, word process, multimedia materials process, and so on, and 6) to improve their love to the hometown and obtain a keenness for learning.

2.4. Procedure

The process of the study includes 4 phases.

Phases 1: ICL Theme and activity design. Two activity themes were designed first according to the project schools’ characteristics and needs. After interviews with the headmasters, the theme “Lovely hometown: I am a small guide” was selected and the elaborated ICL activity was designed.

Phases 2: Strategies and tools development. Strategies were designed and supporting tools were developed for the ICL project, based on the Scaffold Design Framework for ICL. Eight categories of scaffolds were designed, and 18 strategies and 27 supporting tools were designed and developed conversely as shown in Table 2.

Table 2. The Scaffolds and Tools for the ‘Lovely Hometown’ ICL

Scaffold Types	Strategies & Activities	Supporting tools
Goal scaffold	Interpreting of common goals	ICL project introduction (for teacher); Activity introduction (for student); Evaluation criteria
	Signing the learning contract	Learning contract template (teacher edition); Learning contract template (student edition)
Content scaffold	Structuring and presenting the ICL content	Concept map of the ICL project
Group scaffold	Ice breaking	Address book template; School panel template
	Forming a Group	Grouping rules description
	Establishing common identity of the group Making common rules	Examples of Group logo design Group rule template
	Making clear responsibilities	The guideline of role assignment and responsibilities
Interaction scaffold	Brain storming	The guideline of brain storming strategy
	Sharing and communication	Online communication etiquette guide; Online communication skills hints
Data scaffold	Preparing for methods	Introduction of Survey methods, skills, presentation
	Making a plan	mind-map for Resource collection; references of Hometown snacks; template for Data collection plan; outline template for Interview; outline template for Field investigation
	Process recording	Field work recording table
	Data statistics and analysis	Interview and data statistics table
Outcome scaffold	Designing of works	Tourist line design framework; Commentaries outline and examples
	Producing and distributing	Group presentation template
Evaluation scaffold	Making clear evaluation standards	Group product evaluation criteria
	Clarify evaluation methods	Evaluation methods; evaluation criteria for Student performance; evaluation criteria for group product ; evaluation criteria for group performance
Organization scaffold	Optimizing the Organizational structure	

Phase 3: Implementation of the ICL. The ICL was carried out during April to June of 2010.

Phase 4: Summarization and evaluation. At last, students were evaluated through self-evaluation, group evaluation, product evaluation, and teacher evaluation, based on their performance and achievements all through the whole ICL.

2.5. Data Collection

Questionnaires and interviews were used in this study to collect both quantitative and qualitative data. The questionnaire included two parts. The first part aimed to collect feedback from teachers and students on their achievements in this ICL project. The second part of questionnaire was to look into the effectiveness of the scaffolds and tools. A five-point Likert scale was used, asking teachers and students to evaluate the scaffolds and tools by selecting 'very useful (5 points),' 'useful (4),' 'general (3),' 'useless (2),' or 'completely useless (1).' Two-hundred and eight students' effective questionnaires and eight teachers' effective questionnaires were collected.

At the beginning of the ICL project, interviews were conducted to the two headmasters and teachers in order to understand the ICT skills of their students. At the end of the ICL project, interviews were conducted to collect feedback from teachers and students on their achievements, and their feedback on the scaffolds and tools. Nine teachers and 12 students were interviewed.

SPSS 13.0 was used for data statistical analysis. Means and standard errors were used for question one and question two. For question three, average scores and standard errors were used and significance of pairwise differences was examined.

2.6. Coding and Scoring

The study used both quantitative and qualitative methods to evaluate the effectiveness of scaffolds. The quantitative data collection includes the grade of the group, student grade, and questionnaire data. As Dillenbourg (1999) points out that more valid assessment to collaborative learning would be to measure group performance and group achievements rather than individual task performances. In this study, the effects of ICL were assessed by group performance measures, group product measures, and individual performance measures. Group grade was coded with scores of their process performance and group product. A group process performance evaluation criterion was provided for teachers and researchers, mainly examining their team work and online collaboration. Each group was required to 'act' as a tour guide and introduce their tourist design product. Group product was graded according to their product design, writing, and oral speech.

Group grade = group performance measures * 50% + group product measures * 50%

Individual grade = individual performance measures * 50% + group grade * 50%

Student's individual grade was coded with scores of his/her personal performance and achievement and his/her group grade. His/her personal score came from a combination of self-evaluation and group evaluation results, according to the 6 learning outcomes of the ICL project above.

Individual performance achievement is measured in three dimensions: knowledge and skills, process and collaboration, and attitude. This had 13 items in total (as shown in Table 4). Self-evaluation and group evaluation were used.

Table 3. Evaluation Methods

Evaluation content	Evaluation criteria	Who to evaluate
Individual performance and achievement	6 learning outcomes	Self evaluation + group evaluation
Group process performance	Teach-working and collaboration online	Research team evaluation + teacher evaluation
Group product	Product design, writing, speech	Teacher evaluation

Table 4. Individual Performance Evaluation Form

Evaluation Dimension	Evaluation Items (5 points/Item)	Self-evaluation	Group evaluation
Knowledge & Skills	1. My knowledge was widening.		
	2. My ICT skills were improved.		
	3. My communication skills were improved.		
	4. My comprehensive ability was improved.		
	5. My collaborative ability was improved.		
Process & Methods	6. I took part in every activity on schedule.		
	7. I had good collaboration with my team pals.		
	8. I was able to finish my task and contributed to my team.		
	9. I was able to use multiple methods to collect and process data and materials.		
Attitudes	10. I engaged actively in online communication with the other school.		
	11. I love my hometown even more.		
	12. I love study even more.		
In total	13. I'm more willing to communication and collaboration.		
	Individual performance achievement (100 points) = (self-evaluation score + group-evaluation score) ×10/13		

Table 5. Group Performance Evaluation Form

Evaluation Item (10 point/Item)	Score	
	By research team	By teacher
Clear-cut assignment of responsibility, each member has his/her own contribution to the group		
Good collaboration		
Finish all the activities on schedule		
Communicate and feedback actively online		
Good logic and writing quality in online community		
In total		
Group performance achievement (100 points) = research team's evaluation+ teacher's evaluation		

Group performance is evaluated by the research team and the teacher together. Collaboration and communication within and between the groups is mainly examined (as shown in Table 5).

Group product is evaluated by the teacher only. Writing and oral expression are mainly examined in this area.

2.7. Platform

A Web 2.0 online community (www.peercoaching.cn) was used for online communication and collaboration in the ICL project. This platform was developed by Research Center of Distance Education at Beijing Normal University. However, during the course of the ICL, this platform was newly developed, and hence, a demo version was used.

3. Results

3.1. Question 1: Do the Scaffolds Support ICL Effectively?

Before the ICL project, the headmasters, teachers, and students were asked to sign a learning contract to determine their expected outcomes of the school, teachers, and students in this ICL project. At the end of the project, a questionnaire survey was made. The first part of the questionnaire collected the satisfaction of target achievement in this project. The headmasters, teachers, and pupils were asked to evaluate the satisfaction degree of these objectives. Results indicate that objectives were well-achieved in this ICL project and that both teachers and students regarded this ICL project successful.

Table 6. Evaluation Results on Achievements of the ICL Project

Evaluation Item	Very satisfied/ satisfied	General	Dissatisfied/ Very dissatisfied	Mean	Std. Error
Schools'	100%	0	0	4.75	0.442
Teachers'	88.1%	21.9%	0	4.44	0.840
Students'	100%	0	0	4.88	0.345

The table above shows that schools, teachers, and students were satisfied with the achievements in the ICL project, with the mean varying from 4.44 to 4.88, which shows that the ICL project was successful and achieved the expected outcomes. Because both schools and all the participants had no previous experience or knowledge of ICL, the success of the ICL project indicates that the developed scaffolds have supported the ICL project effectively.

Students were most satisfied with this ICL, and the mean of their objective achievement reached 4.88. Schools were also very satisfied with it; the mean was 4.75. By comparison, teachers were less satisfied. In the follow-up reflection and interviews, some teachers expressed that most of objectives were achieved and they were satisfied. The teachers expressed how they “learned how to guide students to engage in ICL,” “had a deep understanding of collaborated learning,” “can use the relevant strategies in our disciplinary instruction,” “learned how to use blog and ICT technologies to communicate and interact with teachers from other schools,” “we have achieved quite a lot,” etc. However, most teachers were not satisfied with the achievement level of the objective “to establish contact and communication with teachers from the other school.” The main reason may lie in

the instability of the platform in which the ICL project was using. The platform was a demo version and was not stable enough. Teachers complained that because of the instability of the platform, they felt frustrated sometimes and their communication with other teachers was not so fluent and adequate as they had expected.

3.2. Question 2: How do the Teachers and Students Evaluate These Scaffolds and Strategies?

Based on the Scaffold Design Model for ICL, eight types of scaffolds were designed, and 18 typical strategies and 27 tools designed and used in the ICL project. The second part of the questionnaire asked teachers and students to evaluate these scaffolds, strategies, and tools.

The evaluation results are shown in Table 7. As the results show, teachers and students were satisfied with the support of these scaffolds and strategies, and most of scaffolds’ means reached 4.35 and above. Group Scaffold was considered most supportive (mean: 4.46), followed with Evaluation Scaffold (mean 4.45) and Data Scaffold (mean 4.43). However, Interaction Scaffold was considered not supportive enough (mean 3.37), mostly because of the technology obstacles of the platform.

Scaffolding Facilitates Inter-School Collaborative Learning: A Case Study in China

Table 7. Evaluation Result of 8 Types of ICL Scaffolds

Scaffold type	Mean	Std. Error
Goal scaffold	4.40	0.89
Content scaffold	4.35	1.10
Group scaffold	4.46	0.84
Interaction scaffold	3.37	1.50
Data scaffold	4.36	1.08
Product scaffold	4.43	1.17
Organization scaffold	4.42	1.06
Evaluation scaffold	4.45	0.98

The top five strategies most supportive to the ICL project are (as shown in Table 8): Understanding the ICL task (Goal Scaffold), Preparing for Investigation methods (Data

Scaffold), Designing of product (Product Scaffold), Producing and Distributing (Product Scaffold), and Forming a group (Group Scaffold).

Table 8. The Top 5 Most Supportive Strategies

Rank	Strategy	Mean	Std. Error	Usage rate
1	Interpreting ICL tasks and goals	4.77	0.545	100%
2	Preparing for Investigation methods	4.72	0.754	99.5%
3	Designing of product	4.71	0.708	99.5%
4	Producing and distributing	4.71	0.719	100%
5	Forming a group	4.70	0.706	99.5%

Top five tools considered most supportive to the ICL project are (as shown in Table 9): ICL project introduction (for Goal Scaffold), guideline of role assignment and responsibilities (for Group Scaffold), group product evaluation

criteria (for Evaluation Scaffold), evaluation criteria for group performance (for Evaluation Scaffold), and grouping rules description (for Group Scaffold).

Table 9. Top 5 Most Supportive Tools

Rank	Tool	Mean	Std. Error	Usage rate
	ICL project introduction	4.61	0.838	100%
	Guideline of role assignment and responsibilities	4.59	0.908	99.5%
	Group product evaluation criteria	4.56	0.995	99.5%
	Evaluation criteria for group performance	4.52	0.981	100%
	Grouping rules description	4.50	1.155	99.5%

3.3. Question 3: Which Intensity Level of Scaffolds Supports Better?

Student’s grade came from his/her formative performance, his/her group’s formative performance, and his/her group product credit, with a full credit of 100 points. Result of the urban school is shown in Table 10. Students’ average grade in Class A (lowest-intensity scaffolding group) was 83.00, 85.33 in Class

B (highest-intensity scaffolding group), and 92.38 in Class C (adaptive scaffolding group). A comparison of the achievements in three different scaffolding conditions (as shown in Table 11) indicated that the achievements of groups with scaffolding of middle or high intensity (Class B and Class C) were significantly higher ($p < 0.05$) than those with lowest-intensity scaffolding (Class A), which suggests that the scaffolds and tools were effective for supporting ICL.

Table 10. Students’ Score in the Urban School

School	Scaffolding condition	Average score	Std. Error
Urban primary school	Class A (lowest-intensity scaffolding group)	83.00	5.543
	Class B (highest-intensity scaffolding group)	85.33	5.770
	Class C (adaptive scaffolding group)	92.38	3.338

Table 11. Comparison of Achievements in Different Scaffolding Conditions in the Urban School

Comparison of scaffolding conditions	Comparison of achievements	Significance
Class A (Lowest-intensity Scaffolding Group) V.S. Class B (highest-intensity Scaffolding Group)	$83.0 < 85.33$	0.323
Class A (Lowest-intensity Scaffolding Group) V.S. Class C (Adaptive Scaffolding Group)	$83.0 < 92.38$	0.001
Class B (Highest-intensity Scaffolding Group) V.S. Class C (Adaptive Scaffolding Group)	$85.33 < 92.38$	0.002

Scaffolding Facilitates Inter-School Collaborative Learning: A Case Study in China

Results of the rural school are shown in Table 12. Students' average grade in Class A (lowest-intensity scaffolding group) was 85.00, 86.33 in Class B (highest-intensity scaffolding group), and 91.67 in Class C (adaptive scaffolding group). A comparison of the achievements in three different scaffolding conditions (as shown in Table 13) show

that, in the rural school, the achievements of groups with scaffolding of middle or high intensity (Class B and Class C) were significantly higher ($p < 0.05$) than those with lowest-intensity scaffolding (Class A), which indicates that the scaffolds and tools were effective for supporting ICL.

Table 12. Students' Score in the Rural School

School	The way of scaffolds supplied	Average score	SD
rural primary school	Class A (lowest-intensity scaffolding group)	83.67	5.000
	Class B (highest-intensity scaffolding group)	91.67	0.002
	Class C (adaptive scaffolding group)	87.67	2.886

Table 13. Comparison of Achievements in Different Scaffolding Conditions in the Rural School

Comparison of scaffolding conditions	Comparison of achievements	Significance
Class A (Lowest-intensity scaffolding Group) V.S. Class B (Highest-intensity scaffolding Group)	$83.67 < 91.67$	0.020
Class A (Lowest-intensity scaffolding Group) V.S. Class C (Adaptive Scaffolding Group)	$83.67 < 87.67$	0.016
Class B (Highest-intensity scaffolding Group) V.S. Class C (Adaptive Scaffolding Group)	$91.67 > 87.67$	0.033

Compared with the rural school, the difference was more significant between the class with lowest-intensity scaffolding and the ones with middle and high scaffolding in the urban school. In the urban school, the results of the adaptive scaffolding group (Class C) was significantly higher ($p < 0.05$) than the highest-intensity scaffolding group (Class B), which indicates that adaptive scaffolding is more supportive than highest-intensity scaffolding. Interviews also show that teachers and students in the urban school preferred middle-intensity adaptive scaffolding. They considered it more inspiring and flexible for

them to decide and select the scaffolding according to pupils' needs and performance.

However, it was interesting that the rural school had a different result. In the rural school, grades in the highest-intensity scaffolding group (Class B) were significantly higher than those in adaptive scaffolding group (Class C). It indicated that on one hand, scaffolding was supportive for the success of ICL in rural schools, and on the other hand, highest-intensity scaffolding was more suitable for teachers and students in rural schools.

4. Discussion

The results of this study suggest that scaffolding is supportive for the success of ICL. Meanwhile, highest-intensity scaffolding supports best for the rural school and middle-intensity adaptive scaffolding supports best for the urban school. Some suggestions are summarized in this study on how to design scaffolds for inter-school collaboration.

4.1. First, Eight Dimensions of Scaffolds Should be Designed for ICL.

The ICL is the most complicated ICT application instructional model in class instruction. Both teachers and students may encounter all kinds of obstacles that may cause the failure of ICL. The results in the first research question indicate that the eight types of scaffolds can provide effective support for the success of ICL in different stages and from different dimensions.

In this ICL project, eight types of scaffolds, and 18 strategies and 27 supporting tools were designed and developed according to the Scaffold Design Model for ICL. These scaffolds supported an urban school and a rural school with no previous ICL experience to accomplish the ICL successfully. Results show that the project made highly satisfactory achievements, and over 88% objectives were achieved. Teachers and students considered that the eight types of scaffolds and tools were all effective. The experimental results also indicated that the achievements of classes with middle- and high-intensity scaffolding were significantly higher than those with lowest-intensity scaffolding. All these results suggest that the eight categories of organizational scaffolds are necessary and essential to ICL. Therefore, instructional designers or teachers should design and develop these eight types of scaffolds to provide all-round and

comprehensive scaffolding support to students in an ICL environment.

4.2. Second, Group Scaffold, Evaluation Scaffold and Data Scaffold Should be Emphasized.

Results in the second research question show that Group Scaffold, Evaluation Scaffold, and Data Scaffold are regarded as the most supportive for ICL. ICL is a form of collaborative learning that needs students to study in groups. Group Scaffold can help students to build a team, to clear their roles and responsibilities, and to establish cohesion and belongingness of a team, which is the foundation of effective and successful collaboration. Evaluation Scaffold is also proved to very important for the success of an ICL that can provide a clear goal and direction for teachers and students, and arouse their initiatives and creativities. As a kind of online inquiry learning, the collection and process of data and multimedia materials are often needed in the process of ICL. These may probably be a bottleneck of ICL for students, especially for rural students. Research also indicates that most ICL projects failed to come to in-depth fruition mainly because most of teachers were unable to provide effective support on data processing. So, these three types of scaffolds are especially crucial for the success of an ICL. Instructional designers should emphasize on the design of these three types of scaffolds: Group scaffold, Evaluation scaffold, and Data Scaffold.

4.3. Last but not the Least, Adaptive Scaffolding Should be Designed for Urban Schools While Rural Schools Need Detailed and High-Intensity Scaffolding.

Results in the third research question show that the urban school and the rural school have different preferences for scaffolding intensity.

With regard to the urban school, adaptive scaffolds with middle coercion supported learning best. In the interviews, teachers in the urban school expressed that ‘rough templates were better and left more space for our instruction and creativity.’ This finding is consistent with the majority of studies on scaffolding in other learning environments (Azevedo et al, 2005). However, as for the rural school, students with highest-intensity scaffolding achieved best. The questionnaire and interview results show that teachers and students in the rural school gave very high praise to these scaffolds and tools, and considered them ‘detailed and thorough, very helpful.’ This finding is different with some studies on scaffolding in other learning environments that found that fixed and high-coercion scaffolding is ineffective (Azevedo et al., 2005; Azevedo et al, 2011; Winne, 2001).

During the course of the study, it was observed that some difference or gap between urban and rural students on the aspects of inquiry learning ability and ICT skills existed. At the beginning of the ICL project, the headmasters and teachers in both schools were interviewed about their students’ ICT levels. The interview results show that students in both schools have regular access to computers and the Internet (2 hours per week at least), and have had the basic skills on how to use a computer and the Internet. So, the prerequisite of the study was that the two schools have basic ICT skills on computer and Internet operation. However, during the course of the study, it was observed that the urban students were obviously more skillful in using applications such as Word, PowerPoint, Paint, and other software. They behaved not only more skillfully, but also more confident in surfing in the Internet and communicating in the online community. This finding is consistent with other studies concerning the digital divide in China. A survey conducted

by the Rural Education Action Project showed that when examining the nominal use of computer and when examining the very basic fundamentals of computer use, the gap between urban and rural did not appear to be large; however, the urban-rural digital divide at school became wider when examining more complicated skills of computer operations such as using educational software and learning about computer hardware (Yang *et al.* 2012).

Further interviews were conducted after the ICL project. Nine teachers and 12 students were interviewed. It is found that although both urban and rural students show great enthusiasm in the ICL project and devote a lot of spare time on it, most of urban students use computer and the Internet at home after school and at weekends. However, only two rural students have an old computer at home, but no Internet access. Hence, the rural students can only use the computer and Internet at school. This finding is similar to Yang’s survey. Yang and colleagues found that the ratios of urban to rural students in the access to ICT services at home ranged from 8:1 to 14.6:1 (Yang *et al.*, 2012).

The interview data also shows that although teachers and students in both schools have no ICL experience before, teachers and students in the urban school did have some experience in conducting school projects.

Most research on educational gap in China emphasizes the divide of exceptional resources (Lang *et al.*, 2012; Lv, 2011). The factor of teachers also matter in this study. Although teachers in the two schools were carefully selected, all of them were between 30 to 36 years in age and have teaching experience between 8 to 14 years. Teachers in the urban school were obviously better educated than rural teachers. Therefore, teachers in the two schools also differed on their ability of guidance and instruction.

All of these divide may explain why adaptive scaffolding is more suitable for the urban school while fixed and high-coercion scaffolding works best for the rural school. Students in urban school have a better pre-knowledge and set of skills and may need less detailed scaffolding during the course of ICL. Teachers in the urban school are also more experienced on guidance and instruction, so they are able to judge, select or adjust scaffolds, strategies, and tools according to their instructional and students' needs. Hence, teachers and students in the urban school need scaffolding with more degree of freedom, which is good for their initiative and creativity that makes individualized instruction possible. With regard to the rural school, because students are relatively poor in knowledge and skills, and it is also difficult for teachers to judge, select and not to say to adapt the scaffolds. Hence, fixed and high-intensity scaffolding is necessary for them to provide detailed and thorough support and aids to them.

5. Conclusion

This study aims to examine the effectiveness of scaffolding design in an inter-school collaboration environment, especially the effectiveness of scaffolding with different intensity and coercion. One urban primary school and one rural school were selected to participate in the inter-school collaboration. Three 6th grade classes in each school were randomly assigned to one of three scaffolding conditions: lowest-coercion scaffolding (class A), highest-coercion scaffolding (class B), and adaptive scaffolding (class C). Scaffolds were designed according to the Scaffold Design Model for ICL. Results of this study suggest that the scaffolds are supportive and effective for ICL's success, and all the eight types of scaffolds are effective and essential for ICL. The results also suggest that students in urban schools in China need adaptive scaffolding,

and that high-intensity scaffolding should be designed and provided for rural students in China. Findings of this study contribute to the growing body of research on scaffolding in technology-based learning environment. The results of this study present some challenges for teachers and instructional designers of ICL that different coercions of scaffolds should be designed and provided according to existing abilities and skills of students and teachers. Future studies between ability level of students and scaffolding intensity is necessary.

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