Designing One-to-One Activities with a Cognitive Conflict Resolution Strategy

Sung-Bin Chang, Emily Ching, Yu-Fen Chen
Dep. of Computer Science and Information Engineering, National Central University, Taiwan
{legend, emily, amychen}@cl.ncu.edu.tw

ABSTRACT

This paper describes a design strategy, called PER, for one-to-one classroom activities. Since there is a gap between the theory and the methodology, PER is applied as a design strategy for a set of collaborative learning activities. One-to-one technologies create the potential for a new phase in the evolution of technology-enhanced learning. With the seamless learning space, students' learning can be carries anywhere and anytime, and the interactions could be different forms and with different number of people. In addition to interpret PI model, other pedagogical model are described and differentiated, analyzed, and positioned with PER strategy and other design strategies.

Keywords: *Cognitive conflict resolution, design strategy, one-to-one classroom*

1: INTRODUCTIONS

The Piaget's theory of cognitive development has inspired many researchers to investigate how social interaction affects individual cognitive development. Doise et al. [1] have shown that two children working together can successfully perform a task which can not be performed by children of the same age working alone. In the subsequent study, Mugny and Doise [2] verify that "more progress takes place when children with different cognitive strategies work together that when children with that same strategies do so, and that not only the less advanced but also the more advanced child progresses when they interact with each other." Subjects at the same level of cognitive development but who enter the situation with different perspectives can also benefit from conflicting interaction, and the peer interaction will be led to improvements in cognitive development.

When a learner is confronted with conflicting situation in the group setting, the learner will be drove to examine his thinking and may look for other possible points of view. He will attempt to solve the conflict. From the social dimension, the conflict situation is seen as providing impetus to resolve the conflict. Such resolution could be achieved to arrive at a more advanced "decentred" solution [3]. The cognitive conflict resolution has been a common design strategy for collaborative learning activities.

As stated in www.g1to1.org, more and more students will possess their own computing devices to participate in the learning activities. The rapid advancement of mobile, connected, and personal technology are gradually transforming the lives of students. The affordances of one-to-one technology across different settings and learning environments suggest an opportunity for seamless learning space [4]. In addition, the capabilities of the one-to-one technologies must be paired with appropriate theories. However, there is a gap existing between the theory and the methodology. In this study, we generalize a design strategy based on cognitive conflict resolution for a set of learning activities in one-to-one classroom. In addition to adopting the original strategy, some methodologies which combine with other strategies are characterized.

2: DESIGN STRATEGY: PER

PER is generalized as one kind of cognitive conflict resolution strategy for a set of collaborative learning activities. It consists of three steps, including producing cognitive conflict, exposing cognitive conflict, and resolving cognitive conflict, to carry out a learning activity. Peer Instruction (PI) is an interactive pedagogical model that engages learners with more intensive instructor-learner and learner-learner interaction in classroom learning [5]. The ConcepTest of the PI model engages students in the cognitive conflict situation. After mini-lecture in class, the instructor in PI classroom initiates a conceptual multiple-choice question and asks students to answer the question without discussion. The responses are exposed to students. Students are asked to discuss with others nearby and encouraged to convince each other of their own answer by explaining the underlying reasoning. The second time committing the answer is conducted after the discussion. We utilize the procedure of ConcepTest to describe the three steps of the PER strategy.

Step 1: "Producing" cognitive conflict

It is important for learners to create their own explanations of the information around them [6]. Composing can help learners retain and relate new information to prior knowledge and give them a chance to start to formulate products by retrieving information from long-term memory. Like the procedure of ConcepTest of PI model, it is important for learners to work on a conceptual question individually at first and produce their own answers as outcomes of the task. Because of the differences in the individual backgrounds, knowledge, and thinking styles, their outcomes might be

different and would be the potential conflicts among them. As the scale is extended to teams, individual team's products could be the potential conflict among teams.

Step 2: "Exposing" cognitive conflict

Learners will be stimulated to examine their thinking and look for other possible solutions by exposing them to the conflict situation. After committing the outcomes, the potential conflicts will emerge as real conflict among them. For the ConcepTest of PI model with wireless handheld devices, the instructor displays the committing result of students' responses of the conceptual question. This operation activates students' more deep thinking and promotes the productive discussion at the next step.

Step 3: "Resolving" cognitive conflict

Nothing clarifies ideas better than explaining them to others. Learners are encouraged to resolving the cognitive conflict by enforcing common outcome. In order to get consensus, learners working together have to elaborate their own thinking, examine and compare with others' elaboration, and make a decision for the outcome. PI model uses an approach, called 'convince-your-neighbors', to encouraging students resolving the cognitive conflict. For the example, PI doesn't strong enforce students to get common outcome. Students are just encouraged to internally resolve the conflicts.

3: SCENARIOS FOR LEARNING WITH ONE-TO-ONE TECHNOLOGY

Seamless learning space consists of scenarios in which learners are active, productive, creative, and collaborative across different environments and settings [4]. The space is collection of numerous scenarios which are across places, number of people working together, and learning activity model. Through the Internet, classroom can be extended to out of the classroom, such as campus, home, museum, etc. The target for interacting with can be none (individual), one (peer-to-peer), a small team, whole class, or a networked community. The instructor is more able to coordinate the students' learning with the capabilities of the one-to-one technology.

While learners work with one-to-one technology and the instructor coordinates the learning activities, leaning scenarios are characterized as individual learning, intra-team interactions, inter-team interactions, and one-to-one interactions. Individual learning means individual human-computer interactions. Individual learner works with his own computer under the coordination by the instructor. The intra-team and inter-team interactions are computer mediated face-to-face interactions. One-to-one interactions can be the instructor's lecture, learner's presentation, or whole class activities, like anonymous voting or quiz. We use semi-languages to portray the learning scenarios as "(individual)", "(individual, group)", "(group, group)", and "(teacher, class)" and "(student, class)" for the instructor-led and student-led learning scenario respectively.

4: EXAMPLES OF APPLYING PER

This section describes four examples of applying PER strategy in the activity designs. In the descriptions of these examples, we use semi-languages to introduce these activities to present how to apply PER in the design.

4.1: Peer Instruction and Just-in-time-teaching

Peer Instruction takes advantage of student interaction during lecture and focuses students' attention on underlying concepts [5]. Mazur replaced the traditional lectures and designed this model to enhance learners' concept understanding in introductory physics course. Unlike the common practice that the instructor directly elaborates the question, each learner is encouraged to immerse in the situation of peer interaction. Learners do not only assimilate the material presented to them, but they must think and express their thought to others. The magnificent advantage of PI is that answers of ConcepTest provide immediate feedback on learners' understanding. It is important for students to have some familiarities with the learning material. PI model has been replaced the reading quizzes with a modified form of the Warm-up exercise of the Just-in-Time Teaching (JiTT) approach (Novak et al., 1999). JiTT, when incorporated with peer discussion on some puzzle questions, was also reported to significantly improve student morale and performance [7]. Fig1(a) shows the semi-language form of the modified PI model with JiTT approach as the pre-class reading assignment. PER is implicated at the 4^{th} to 6^{th} step. After the first time committing, the 'convince-your-neighbors' is presented as 'elaborating(student, student)', which means one student elaborates his idea to other student. And then, operate the second committing.

```
1.  reading();
2.  committing(individual, response);
3.  lecturing(teacher, class);
4.  committing(individual, selection);
5.  elaborating(student, student);
6.  committing(individual, selection);
7.  elaborating(teacher, class);
8.  discussion(teacher, class);
```

Figure 1. The procedure of PI and JiTT in semi-language

4.2: TIPS

Chen et al. [8] adapted PI model which combined with JiTT approach for a new interactive pedagogical model, called TIPS which stands for "Think-Individually-then-Peer-Share". Dissimilar to the

PI model, TIPS uses small-group collaboration instead of ad hoc interaction. In addition to compose individual response for the pre-class reading quiz, students at the same group have to get a consensus to commit the assignment. For the classroom activity, TIPS adopts the design of the activity sequence in MCSCL [9] with PDA to replace the 'convince-your-neighbors' of the PI model. TIPS demands for consensus of committing as a strong enforcement of resolving cognitive conflict. The semi-language form of TIPS is shown as fig1(b). After the individual committing of the reading quiz, students have to assess others' responses at the same group. The results of the assessment would be the potential conflict for students to resolve. They must commit a group response at the second time committing step. For the class activity, students elaborate their ideas to the group members to achieve consensuses.

```
1.  reading();
2.  committing(individual, response);
3.  assessment(individual, group);
4.  elaborating(student, group);
5.  committing(group, response);
6.  lecturing(teacher, class);
7.  committing(individual, selection);
8.  elaborating(student, group);
9.  committing(individual, selection);
10. discussion(teacher, class);
```

Figure 2. The procedure of TIPS in semi-language

4.3: AGQ

AGQ, which stands for "asking a good question," is the activity model engaging students in designing penetrating questions and evaluation of answers [10]. The activity of designing question and answer (Q&A) helps students retain and relate new information to prior knowledge, indicate which part of the learning material is important and worth to test, and clarify his comprehension of the learning material. AGQ adopt PER strategy twice in the model design, shown as fig1(c). The first PER adoption is to encourage the intra-team interactions. In the stage, students work with their teammates to get a consensus for the group questions. The second PER is for the inter-team interactions. Two groups interact with each other at this stage and finally get agreements of the members in the two groups.

```
1.  reading();
2.  committing(individual, q&a);
3.  assessment(individual, group);
4.  elaborating(student, group);
5.  committing(group, q&a);
6.  assessment(group, group);
7.  elaborating(group, group);
8.  committing(group, q&a);
9.  quiz(individual);
10. discussion(teacher, class);
```

Figure 3. The procedure of AGQ in semi-language

4.4: P3T

It has been found that having students teach each other increases their achievements at various educational levels [11][12]. P3T [13], which stands for preparing and performing peer tutoring, is a systematic design to help students carry out three tutoring activities, including learning about the materials, composing tutoring notes, and conducting face-to-face tutoring. P3T presents PER combining with reciprocal peer tutoring. Fig1(d) shows the semi-language form of the P3T model. For the stage of preparing tutoring note, each student has to individually compose his note and go through the process of eliminating the differences to commit a group note. In class, student tutors take responsible to teach student tutees, which presents as 'lecture(student, group)' that means student-led lecturing in small-group. After the tutoring process, a formative assessment is took to examine the comprehension of the learning material.

```
1.  reading();
2.  committing(individual, note);
3.  assessment(individual, group);
4.  elaborating(student, group);
5.  committing(group, note);
6.  lecture(student, group);
7.  committing(individual, response);
8.  elaborating(student, group);
9.  committing(individual, response);
10. discussion(teacher, class);
```

Figure 4. The procedure of P3T in semi-language

5: SUMMARY

One-to-one technologies will create the potential for a new phase in the evolution of technology-enhanced learning. Learners can learn anywhere and anytime with personal learning devices and seamlessly switch among different scenarios to carry out learning activities and interact with other learners in different formation or scale. The developments of learning scenarios, supported by social learning theories, will influence the learners' learning in cognitive development. The uses of one-to-one technologies may extend the social learning space and bridge the student's learning in school and outside of school.

In this study, we indicate the effectiveness of cognitive conflict resolving in collaborative learning. Some pedagogical methodologies with great achievements comprise the elements of the theory of cognitive development. However, there is a gap between the theory and the methodology. We base on the theory of cognitive conflict resolving and propose PER as a design strategy for a set of learning activities in one-to-one classroom. The reformed PI model, which combined with JiTT, is the first example involved with PER. TIPS extends the design of PI with strong enforcement of common outcome. AGQ comprises twice PER in the model design. P3T combines PER

with the learning strategy, which is 'reciprocal peer tutoring'. More pedagogical mode will be designed with PER in different form.

Acknowledgments

The authors would like to thank the National Science Council of the Republic of China, Taiwan, for financially supporting this research under Contract No. NSC94-2520-S-008-003.

REFERENCES

[1] Doise, W., Mugny, G., and Perret-Clermont, A.-N. (1975) Social interaction and the development of cognitive operations. *European Journal of Social Psychology*, **5**, 3, 367-383.

[2] Mugny, G. and Doise, W. (1978) Socio-cognitive conflict and structure of individual and collective performances. *European Journal of Social Psychology*, **8**, 181-192.

[3] Dillenbourg, P., Baker, M., Blaye, A., and O'Malley, C. (1996) The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds.) *Learning in Humans and Machine: Towards an interdisciplinary learning science*, (pp. 189-211). Oxford: Elsevier.

[4] Chan, T. W., Roschelle, J., His, S., Kinshuk, Sharples, M., Brown, T., Patton, C., Cherniavsky, J., Pea, R., Norris, C., Soloway, E., Balacheff, N., Scardamalia, M., Dillenbourg, P., Looi, C. K., Milrad, M., Hoppe, U., and G1:1 members (2006) One-to-one technology-enhanced learning: An opportunity for global research collaboration. *Research and Practice in Technology Enhanced Learning*, **1**, 1, 3-29.

[5] Mazur, E. (1997) *Peer Instruction: a User's Manual*. Prentice Hall, New Jersey.

[6] Geelan, D. R. (1997) Epistemological Anarchy and the Many Forms of Constructivisim. *Science & Education*, **6**, 15-28.

[7] Novak, G.M., Patterson, E.T., Gavrin, A.D., and Christian, W. (1999) *Just-In-Time Teaching: Blending Active Learning with Web Technology*. Prentice Hall.

[8] Chen, Y. F., Lin, W. H., Chang, S. B., Liu, C. C., and Chan, T. W. (2005) TIPS: A JiTT and PI pedagogical method with handheld computer as mediating tools. *In proceedings of the 5th IEEE International Conference on Advanced Learning Technologies*, (pp. 844-845).

[9] Cortez, C., Nussbaum, M., Santelices, R., Rodríguez, P., Zurita, G., Correa, M., and Cautivo, R. (2004) Teaching science with mobile computer supported collaborative learning (MCSCL). *In proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education*, (pp. 67-73).

[10] Chang, S. B., Tung, K. J., Huang, H. M., and Chan, T. W. (2005) AGQ: A model of student question generation supported by one-on-one educational computing. *In proceedings of Computer Supported Collaborative Learning 2005: The Next 10 Years!*, (pp. 28-32).

[11] Cohen, P.A.; Kulik, J.A.; Kulik, C.L.C. (1982) Educational outcomes of tutoring: a meta-analysis of findings. *American Educational Research Journal*, **19**, 237-248.

[12] Falchikov, N. (2001) *Learning together: Peer tutoring in higher education*. London: RoutledgeFalmer.

[13] Ching, E., Chen, C. T., Chou, C. Y., Deng, Y. C., and Chan, T.W. (2005) A pilot study of computer supported learning by constructing instruction notes and peer expository instruction. *In proceedings of Computer Supported Collaborative Learning 2005: The Next 10 Years!*, (pp. 63-67).