Introduction
Recently, networked peer assessment has emerged as a means to achieve social knowledge construction (Liu, Lin, Chiu & Yuan, 2001). Topping (1998) claimed that under an imitated social circumstance, the students evaluating other students’ assignments enhanced cognitive thinking among the students. In the social sciences, many studies focused on the effectiveness of feedback (Butler & Winne, 1995). However, in the areas of computer science-related courses and networked peer assessment, only a few studies have explored the relationship between the types of peer feedback and cognitive and metacognitive strategies (Lin, Liu & Yuan, 2001), and the relationship between the levels of these strategies and students’ achievement in networked peer assessment.

Method
The participants comprised 46 junior Information Management majors attending a university of science and technology in Northern Taiwan. They were students enrolled in a mandatory course titled ‘Internet technology’. The course objectives stipulate that students should learn the basics of the Internet, wireless networking, tags for data on the Internet and Active Server Pages, and should be capable of designing a complete web-based system. The achievement of the students was measured through an assignment. Each assignment was rated (ranging from 1 to 10) by five peer reviewers; each peer reviewer had to review five assignments. The assignment score (ranging from 1 to 10), awarded by the teacher based on the peers’ evaluations, was a combination of their performance in two rounds of peer assessment.

Content analysis was adopted to analyse two perspectives of peer feedback: content and cognitive/metacognitive strategies. Both were completed by a graduate student majoring in computer science and a college teacher with a major in educational psychology. The first perspective—content of peer feedback—was further analysed by classifying it into four categories: emotional wording, descriptive document, program debug and evaluation/modification suggestions. The following are examples of each category:
• ‘You and your project is useless’ (emotional wording);
• ‘The function of submission of personal information in your proposal is written in a manner that is not very clear’ (descriptive document);
• ‘The file submission function does not work when the file to be uploaded is larger than 10 MB’ (program debug); and
• ‘The performance of your program is not good enough, and I suggest that you use another more efficient algorithm such as...’ (evaluation/modification suggestion).

The second perspective—cognitive and metacognitive strategies observed in peer feedback (Butler & Winne, 1995)—were classified into the following four categories: description, simple judgement, elaborated judgement and suggestion. Description includes stating observations and refraining from the use of judgmental words that clearly express approval or disapproval. Simple judgement includes arriving at a conclusion without providing an explanation for it. Elaborated judgement includes a clear expression of both a favourable and an unfavourable opinion; further, it involves an explanation for the basis on which this judgement is made. Suggestion not only includes proposing improvements to the assessee, but also stating a viewpoint on the topic of the assignment.

In this case, the interrater reliability coefficient is 0.93. Further, the interrater reliability coefficients of the Computer Science and Educational Psychology majors are 0.91 and 0.95 respectively. Finally, the four levels of cognitive and metacognitive strategies were classified in the following manner: description and simple judgement are classified as the ‘beginner-level cognitive and metacognitive strategies’, while elaborated judgement and suggestion are classified as the ‘advanced-level cognitive and metacognitive strategies’.

Findings

Types of peer feedback and types of cognitive and metacognitive strategies

A Chi-square test for a $4 \times 2$ contingency table was conducted with the four types of peer feedback—emotional wording, descriptive document, program debug and evaluation—and two levels of cognitive and metacognitive strategies (Table 1). As expected, the results indicated a significant difference ($\chi^2 = 34.21, df = 3, p < 0.001$). This indicates that providing three of four types of feedback, eg, descriptive document,
program debug and evaluation, enabled the use of more advanced cognitive/metacognitive strategies. However, all emotional wording feedback types reduced the use of cognitive/metacognitive strategies. In addition, the Cramer’s V value is 0.31 ($p < 0.001$), indicating a relatively low but significant correlation. Hence, there exists a relationship between the types of peer feedback and the levels of cognitive and metacognitive strategies. In addition, the predictive power, when applying the types of peer feedback on the levels of cognitive and metacognitive strategies, is 17.2% ($p < 0.001$).

Levels of cognitive and metacognitive strategies and achievement

On average, every student adopted 3.57 beginner-level cognitive and metacognitive strategies, within a range of 0 to 8; however, a great variation is observed ($SD = 2.42$). Moreover, on average, every student adopted 3.93 advanced-level cognitive and metacognitive strategies, within a range of 0 to 9; a large variation is observed in this case as well ($SD = 2.68$). Finally, students’ achievement was 6.87 on average, within the range of 4 to 10; there was a relatively small variation ($SD = 1.52$).

The results of a regression analysis revealed a significant relationship between the use of cognitive and metacognitive strategies in feedback and in students’ own achievement under networked peer assessment. The results indicated that students’ use of advanced-level cognitive and metacognitive strategies was a positive and significant predictor of their own achievements ($achievement = 0.69 \times \text{advanced-level cognitive and metacognitive strategies} - 0.32 \times \text{beginner-level cognitive and metacognitive strategies}$, adjusted $R^2 = 0.86$, $p < 0.001$). In other words, students who offered higher order thinking feedback more often tended to achieve higher scores; those who performed better in this class are also more capable of offering high-quality feedback to peers. In the review of the cognitive functions of feedback (Butler & Winne, 1995) and that of the feedback and its roles in peer assessment (Topping, 1998), researchers claimed that the receiver of higher-quality feedback may perform better in the later work, but they did not state which students are capable of giving better quality feedback to peers. This study contributes to the research on feedback in terms of the finding that those who are capable of designing a project alone (for a complete web-based system in this study) can offer good feedback. Therefore, we suggest that the teacher assign more review tasks to students who perform successfully in the previous peer assessment; alternatively, for each assignment, there should be a higher achiever as the peer referee in order to help each student improve. In addition, the teacher can encourage peer modelling by providing samples of high-quality feedback to those students who were less successful. The teacher can also demonstrate how to serve as a better referee in the case of readme files by using a step-by-step approach through text and visual aids.

Discussion

The results of the study indicated that students are capable of using advanced-level cognitive and metacognitive strategies in providing feedback. However, they also displayed the tendency to provide less elaborate feedback with lower cognitive and metacognitive strategies. If they are requested to provide evaluative comments or modification suggestions, they are more likely to show a higher level of cognition. A higher
level of cognition is, in turn, the key factor in achieving excellence. Therefore, we strongly recommend that teachers carefully design the assessment-related activities and encourage students to engage in and practice advanced-level cognitive strategies whenever it is appropriate. In doing so, students are not only provided with opportunities to practice higher order thinking but also achieve the objective of social constructivism (Rogoff, 1990).

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References