

## USING PEER FEEDBACK TO IMPROVE LEARNING VIA ONLINE PEER ASSESSMENT

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### ABSTRACT

This study investigates the influence of various forms of peer observation and feedback on student learning. We recruited twelve graduate students enrolled in a course entitled, Statistics in Education and Psychology, at a university in northern Taiwan. Researchers adopted the case study method, and the course lasted for ten weeks. Students were first required to learn the content and complete homework assignments through online peer assessment activities. Data were collected from interviews and student journals for content analysis. The results demonstrate that the quality of feedback improved from the first peer assessment to the second; however, the amount of advanced feedback decreased. Although students adjusted their homework according to the feedback provided by their classmates, they did not fully accept this criticism. Students valued specific feedback more highly than scores; however, the desire to obtain high scores motivated many students to modify their papers. When students discovered that peer reviewers were unable to understand their work, they would rewrite it with more extensive explanations and adopt feedback to generate new ideas or research directions. Finally, the students made valuable modifications to their work with the help of feedback from others, and most of the students had a positive impression of peer observation after participating in online peer assessment activities.

**Keywords:** peer feedback; online peer assessment; case study; peer observation.

### INTRODUCTION

Traditional academic assessments often cause negative feelings or anxiety among students. It is important to learn how to use this kind of assessment to enhance students' progress and avoid the negative effects. The common characteristics of achievement tests are as follows: (1) standardization; (2) designated test duration and limits to the use of self-controlled learning strategies for searching and verifying answers; (3) strictly limited to individual participation; (4) insufficient context regarding the terms used in test items; and (5) resulting anxiety and self doubt in participants. Paragraphs in the reading comprehension portion of achievement tests are generally short, unnatural, and de-contextualized and multiple-choice questions prevent students from constructing meaning.

Various alternative assessment methods have been proposed that are distinct from the one-way summative evaluation methods such as standardized testing. Formative evaluation provides feedback to learners and instructors at multiple points in time, according to which learning and instruction may be adjusted. Sahin (2008) found that evaluation by one's peers is very similar to evaluation from lecturers and recommended peer assessment as an alternative method applicable in higher education environments. Vygotsky argued that dynamic assessment could be used to evaluate student performance and potential development throughout the learning process (Dixon-Krauss, 1996). Furthermore, it was suggested that formative evaluation has a positive educational function, making it worthy of further promotion.

Internet technology is now being widely applied in the field of education to enhance the professional development of instructors (Duran, Brunvand, & Fossum, 2009; Liu, Shih, & Tsai, 2011) or promote learning and the development of skills (Allsop, 2011; Kilimci, 2010; Liu & Chang, 2010; Liu, Lin, & Chang, 2010). The idea of online peer assessment has recently been proposed, in which learners grade their peers, provide feedback, and complete individual assignments through online collaboration (Liu, Lin, & Yuan, 2001). Peer assessment in an online environment can be more efficient than in a traditional classroom setting and reduce the cost associated with brick and mortar education (Lin, Liu, & Yuan, 2001; Liu, Lin, & Yuan, 2001). Learners can improve their performance through homework assignments and the feedback they receive from others while participating in

networked peer assessment (Wen & Tsai, 2008; Tsai & Liang, 2009). Indeed, the interaction and feedback provided by online peer assessment enhances learning and enables students to acquire knowledge by reflecting on the observations of their peers and the feedback they receive (Lin, Liu, & Yuan, 2001; Liu, Lin & Yuan, 2001). Peer observation and feedback are crucial to the online peer assessment process. Students assume the roles of author and reviewer simultaneously, complete assignments, inspect and learn from others, provide suggestions, receive feedback, and make adjustments to their own work. Through this process, students gradually develop into self-regulated learners.

Previous studies on peer assessment have focused on the reliability of student grading. Falchikov and Goldfinch (2000) conducted a meta-analysis of 48 quantitative peer assessment studies comparing the marks from peers and teachers, which demonstrated that students are generally able to make reliable judgments. A number of recent studies (Chen & Tsai, 2009; Liu & Carless, 2006) have investigated the role of peer feedback in online peer assessment. Chen and Tsai (2009) examined the role of peer feedback in the subsequent performance of participants, revealing that the quantity of feedback obtained during the first round of evaluation (particularly meta-cognitive-oriented feedback such as 'Evaluating and Planning' and 'Regulating and Reflecting'), is positively correlated with improvement from the first to the second round. However, some forms of peer feedback do not play a significant role in the progression between the second round and final rounds. Davies (2006) also emphasized the importance of judging students' work through comments rather than marks. However, few studies have explored the function of peer feedback in an online peer assessment environment. Furthermore it remains unclear the degree to which students who review the work of their peers benefit from the process, as a consequence of having to develop the sophistication required for peer observations. The purpose of this study was to address the following questions:

- (1) How do the first and second peer assessments differ in the process of peer feedback?
- (2) What role does peer feedback play in improving performance in learning tasks?
- (3) How do students view peer observation?
- (4) Does peer feedback in an online environment influence students in their work?

### **Functions of Peer Feedback**

There are two kinds of feedback: (1) inner feedback and (2) outer feedback (Bangert-Drowns, et al., 1991). Inner feedback focuses on student's knowledge, goal setting, and execution; outer feedback provides domain-specific knowledge and learning strategies. Through peer feedback, learners perceive the relationship between suggestions and achievement, which enhances the execution of their work. A number of studies have found that more detailed feedback helps students to learn more effectively (Chen, Liu, Shih, Wu, & Yuan, 2011; Bulter & Winne, 1995; Liu & Lin, 2007). Feedback can help students to evaluate themselves and identify important methods for revising assignments, all of which are very important abilities in the development of self-regulated learning.

Nilson (2003) described how teachers can use peer feedback as an alternative method of evaluation to help students gain important life skills. Students who are encouraged to transform the feedback they receive into a neutral and formative assessment come to view the process of peer feedback as a valuable activity. It is highly beneficial for students to receive the feedback of others, and it enhances their reflective and analytical abilities (Falchikov, 1995). If learners are unable to understand the advice they receive and adjust their learning appropriately, the feedback does not influence the process of self-regulation (Winne, 1982; Winne & Marx, 1977; 1982). However, it is unclear whether learners fail to assimilate feedback because they do not agree with it or because they do not understand it. This study provided learners with the opportunity to evaluate their peers, whereby learners could comment on or challenge the feedback they received. This process was meant critical thinking and the meta-cognitive skills of learners.

The suggestions generated by peer assessment lead students to confirm their existing knowledge or to expand it. Conflict often arises between the methods the students learn and those they use to complete their homework. These inner activities are the processes of self monitoring. Students may alter their knowledge or beliefs, but more importantly, the processes influence learners' self regulation (Bulter & Winne, 1995). What actions will students take to narrow the differences between their own goals and the feedback and suggestions they receive from others in the process of peer assessment? They may modify their learning goals or try to use new strategies to present their ideas. However, the students may also be misled by the feedback and develop misconceptions of their work and their actual abilities.

Zhao (1998) categorized various kinds of feedback, the highest of which is critical feedback used to describe the strength of the work and provide suggestion for adjustment. It has been demonstrated that high-quality feedback

precedes high-level thinking. In addition, students receiving advanced feedback have shown more pronounced improvement in their learning performance (Tseng & Tsai, 2007).

Bulter and Winne (1995) examined outer feedback in the social cognitive learning process and discussed five different functions of feedback: (1) confirmation: feedback can help learners to confirm whether the learning objective was achieved; (2) expansion: when information is lacking, feedback can provide useful information; (3) replacement: when learners receive incorrect or unsuitable information, feedback can help them to correct it; (4) tuning: feedback can assist learners to refine their understanding of a concept; and (5) restructuring: when preconceptions conflict with new learning material, feedback can help learners to rebuild their knowledge.

Moreover, Bulter and Winne (1995) stated that when learners are asked to provide feedback, they have to decide whether to make adjustments according to the feedback they themselves receive during peer assessment. During this process, learners continually adjust and enrich their domain knowledge. Through self-monitoring, learners filter the information to determine the characteristics of each task, its learning objectives, and relevant learning strategies. Moreover, through peer observation and feedback, learners confirm, adjust, and reconstruct their knowledge and beliefs.

**METHODS**

**Participants**

This study recruited 12 graduate students (11 females and 1 male) enrolled in a course entitled, Statistics in Education and Psychology, at a university in northern Taiwan. All of the students were required to participate in the peer assessment activities in the computer laboratory in which the course was held to avoid unfair assessment.

**Online Peer Assessment Activity**

During peer assessment activities, the students had to assume various roles. They had to complete their work, review the work of others, provide others with feedback, and reflect on the feedback they received. To enhance the influence of observation on learning and provide multiple instances of feedback, the students were required to give an oral presentation in the class. The standards of evaluation were generated from a discussion between the teacher and students (see Table 1). After completing a homework assignment, the students participated in peer assessment activities in class. This study differed from that of Falchikov (1993), which viewed feedback as the channel by which students provide suggestions without scoring the work of others.

**Table 1:** Evaluative standards for homework assigned in the statistics course

Dimensions	Evaluative standards	Suggestions
Research questions and research design	Was the topic focused on educational issues?	
	Were the research questions clear?	
	Research hypothesis: Alternative hypotheses & Null hypotheses (Correctness)	
	Research hypothesis: Alternative hypotheses & Null hypotheses (Clarity)	
Report commentary	Was the statistical method suitable?	
	Were the statistics tables presented and formatted in APA style?	
	Were all important data presented?	
	Was any explanation of important data provided?	
Research conclusion	Was any explanation of the statistical significance of the data provided?	
	Were integrated explanations of the research questions, hypotheses, and results given?	

In this study, the online peer assessment process was reciprocal and anonymous. In other words, the assessors and those being assessed did not know each other’s identities. Online peer assessment was performed in two rounds, such that students were matched in each round. Two rounds of peer assessment gave students the chance to revise their homework according to reviewers’ comments without spending too much time on it. Previous studies have also shown that two rounds of peer assessment can help students to improve the quality of their homework (Tsai, Liu, Lin, & Yuan, 2001). Three or more rounds may help students to further improve their homework, but this study was limited in time. Students assessed and were assessed by the same peer in both

rounds. In the online peer assessment system, students submitted their homework, reviewed and graded the work of others online, and reviewed the feedback they received. One of the advantages of online peer assessment is anonymity. Zhao (1998) indicated that anonymity can increase the reliability and validity of peer assessment, prevent participants from feeling pressured into giving positive assessments to maintain social relationships, and make the participants feel comfortable when providing critical feedback. Moreover, online peer assessment makes the transmission of information fast and convenient.

Following self- and peer assessments, the students adjusted their work according to the feedback they received. The instructor also monitored the peer feedback and met with participants to ensure that reviews were conducted appropriately. For example, when a student posted the same comments for all reviews, the instructor asked for an explanation. The student responded that he was checking whether the instructor really monitored their activities and asked for a chance to modify his reviews. No other events occurred following peer assessment activities. After the peer assessments, the students gave oral presentations to the class, during which they observed the work of others and received additional feedback on their own ideas. At the end of the semester, the students handed in their completed work.

**Instrument and Data Analysis**

Two experts were consulted to analyze the functions of feedback. To avoid personal bias, the two experts used the same criteria to categorize feedback. SPSS statistical software was used to calculate Cohen’s kappa coefficient to measure inter-rater agreement. The kappa coefficient measures the percentage of data values on the main diagonal of the table and then adjusts these values according to the degree of agreement that could be due to chance alone.

First, the two experts categorized feedback separately, according to the same standards. Then, Cohen’s kappa coefficient was calculated. A statistically significant value of Cohen’s kappa coefficient indicates that the two raters achieved satisfactory agreement. In this study, Cohen’s kappa was higher than .70 (Kappa= .89,  $p < .001$ ), indicating that the two raters achieved acceptable levels of agreement (97.72%).

A semi-structured interview was used to understand the roles of peer feedback and peer observation in homework performance. The interview format was adapted from the self-regulated learning interview schedule (SRLIS) developed by Zimmerman and Martinez-Pons (1986; 1988). Eleven students were interviewed individually, and one female student did not consent to be interviewed.

**RESULTS**

**Functions of Peer Feedback**

To ascertain the differences in the function of peer feedback between the first and second assessments, we collected all instances of feedback from all phases of the study and sorted them by functional type. The sources of the data are the first and second peer assessments, during which the students delivered feedback and suggestions to a peer and received feedback and suggestions from a peer. Following classification of the data, there were 712 items available (see Table 2).

**Table 2: Functional classifications of peer feedback**

	Confirmation	Expansion	Replace or overwrite	Tuning	Restructuring
Counts	457	116	78	46	15

In Table 3, we provide typical examples and classify the feedback according to the basic purposes of confirmation, expansion, and replace or overwrite, and the advanced purposes of tuning and restructuring. For the basic functions of feedback, there were 457 instances of confirmation, 116 of expansion, and 78 of advice to replace or overwrite. For the advanced functions, there were 46 instances of advice for tuning and 15 for restructuring.

**Table 3: Typical examples of feedback according to function**

Feedback function	Typical examples
Confirmation	The research topic, preface, content, background, and research methods are clearly defined and explained and easily capture others’ attention and curiosity.
Expansion	Suggestions: if there were more explanation of different thinking styles,

	such as administrative style, judicial style, and legislative style, it would be easier for others to understand the characteristics of different thinking styles and how teachers could guide students with different thinking styles.
Replace or overwrite	In 1.1, for better correspondence to H1, I suggest you modify H0 - student's gender and grades are independent.
Tuning	Because there are too many research questions in your research design, others could confuse the definition of the null hypothesis with the definition of the alternative hypothesis. Also, some research results do not totally support the alternative hypothesis (research question 2) and could not even reject the null hypothesis. Because of this, the correctness is questionable.
Restructuring	In research hypothesis 2, you confuse the null hypothesis and alternative hypothesis.

The students' feedback from two peer assessments is summarized and categorized according to the functions of peer feedback (See Table 4). The differences in the type of feedback and number of suggestion between the two assessments can be observed.

**Table 4:** Feedback function counts for the two peer assessment activities.

	First peer assessment	Second peer assessment
Confirmation	245	212
Expansion	53	63
Replace or overwrite	35	43
Tuning	31	15
Restructuring	11	4

Table 5 is sorted according to feedback function type. We categorized confirmation, expansion, and replace or overwrite as basic feedback. Tuning and restructuring were categorized as advanced feedback.

**Table 5:** Feedback of the peer assessment within advanced and basic functions

	First peer assessment	Second peer assessment
Basic feedback	333	318
Advanced feedback	42	19

To confirm the differences in the functions of peer feedback between the first and second peer assessments, chi-square tests were used to process the number of instances of each type of feedback. The results are shown in Table 6.

**Table 6:** Chi-square tests of the feedback

	Chi-square
Confirmation	2.38
Expansion	0.86
Replace and overwrite	0.82
Tuning	5.57*
Restructuring	3.27
Basic feedback	0.35
Advanced feedback	8.67**

\*  $p < .05$  \*\*  $p < .01$

Table 6 shows the differences between the functions of feedback used in the first and second peer assessments. Significant differences between assessments were observed for feedback categorized as tuning and for overall

advanced feedback. In the second peer assessment, there were fewer instances of advanced and tuning than in the first peer assessment.

Despite the reduction in advanced feedback, the quality of the feedback improved. In the second round of peer assessment, the students gave deeper and higher quality feedback, and were better able to understand the essence of each research issue. Examples are shown in Table 7.

**Table 7:** Examples of feedback functions in two peer assessment activities

Evaluator	Suggestions from the first peer assessment	Suggestions from the second peer assessment
Student L	The outline of this research is complete and detailed just like a short dissertation, perfect. (confirmation)  But in the final part of the explanation, in addition to the discussion of research results, it is suggested to add some suggestions or vision for the future, which would make this paper even better. (expansion)  ...	Research goal and questions to be answered should consider the influence of self-efficacy and learning performance because we should discuss the two dependent variables and independent variables independently, then discuss the impact of the interaction between these two independent variables on the dependent variable. (tuning)  ...
Student A	... The research topic focuses on the educational field. (confirmation) The research questions are clearly described. (confirmation)  In the first part, the research goal and research hypothesis do not match. The research goal was defined as “there is no difference”, but the null hypothesis was defined as “they are the same”. (replace and overwrite)  Research hypothesis was succinctly described. (confirmation)  The statistical method matched the needs of testing the research hypothesis. (confirmation)  The summary of statistical results followed the APA format. (confirmation)  However, in Table 1, the $p < .05$ should be modified to $p > .05$ . (restructuring)  ...	This research was very complete. From the introduction to the explanation of the research topic and research results, it provided a complete description. (confirmation)  In Table 2, some details have to be added, such as putting a “*” on the values that are statistically significant. (replace and overwrite) The research result should reject the null hypothesis and support the alternative hypothesis; however, in the research goals, it seems that you want to reject the alternative hypothesis and support the null hypothesis. A substantial modification is needed to correct this error. (restructuring) In the conclusion, except for the explanation of research goals, you have incorporated your own opinion, and this expands the research. (confirmation) The final suggestion is that you can think about which variables would influence this research topic, and these could be the suggestions for future study and make this paper more prospective. (expansion)

When comparing feedback functions and the number of instances between the first and second peer assessments, we found that a greater quantity does not lead to a higher quality. Table 7 provides examples of the feedback given in the two peer assessments. It is clear that, in example one, student L gave two kinds of feedback in the first peer assessment activity (confirmation and expansion), but gave only one kind of feedback and moved to a

higher level (to the tuning category) for the same assignment in the second peer assessment. For this student, we found that the feedback count decreased from the first to the second assessment, but the quality of the feedback improved. In general, the students received more advanced feedback from the first peer assessment activity, revised their homework based on this feedback, and presented it in the second peer assessment activity. In this research, the same evaluator was assigned to one assignment for both peer assessment activities. In the second peer assessment, the obvious decrease in advanced feedback could indirectly demonstrate that the feedback influenced the students' performance by encouraging them to modify their homework.

In Table 7, student A gave a total of 11 instances of feedback (some instances of feedback are not shown), including 9 instances of confirmation, 1 of restructuring and 1 of replace or overwrite, but in the second peer assessment for the same assignment, student A only gave 5 instances of feedback, including 2 of confirmation, 1 of expansion, 1 of replace or overwrite and 1 of restructuring. Therefore, although the student's instances of advanced feedback decreased, for each case, the feedback quality improved significantly. Moreover, if the students modified their homework as much as possible and better understood the key point of the task after receiving others' feedback, it is understandable that the number of instances of advanced feedback and tuning and restructuring feedback would decrease.

### Peer Feedback for Improving Learning Tasks

Carver and Sheier (1990) indicated that when students obtain unanticipated feedback their desires for self-regulation and self-monitoring are aroused. Extrinsic feedback helps learners to acquire domain knowledge and monitor their own learning. After interviewing the students, we found that they felt that the feedback was beneficial to their learning, saw the feedback as a tool for enhancing their learning, and were willing to adjust their domain knowledge according to the suggestions given by their peers. Some important findings regarding the feedback were as follows:

*Adjust Homework with Conditional Acceptance of Others' Suggestions.* The students adjusted their homework according to the feedback provided by their classmates, but they did not accept it entirely. The mechanism of intrinsic self-regulation drove the learners to search for information related to the feedback given, to verify it, and to choose adjustments that were in line with correct and useful feedback. Therefore, extrinsic feedback influenced not only the regulation of cognition but also the learning behavior (homework adjustment).

**Student D:** I did not accept all of the advice from others because I didn't think all of the feedback was correct or useful. Therefore, sometimes I preferred to use my own idea and reject suggestions. This is what I did: before modifying my article, I consulted others' feedback first, and if there was anything that needed to be improved, I modified it based on the good suggestions. In this way, I adopted this advice.

**Student D:** I first reviewed the feedback of others, and skipped the items that only mentioned what I did fairly well and went directly to those instances of feedback that pointed out the defects in my homework. Then, I checked which methods provided by others would most improve my weak points. After that, I rechecked what I did, and if the feedback provided by others was better, I modified my work.

**Student G:** I saved the feedback from peer assessment activities in a Word file. Then I modified my homework using this Word file. Usually, I ignored instances of feedback that praised what I did well, and I followed the feedback items one by one to rewrite my homework. Moreover, I highlighted the modifications with red ink. For those feedback items that I did not understand, because I did not know whom to ask [for clarification], I consulted other textbooks. If I found some evidence that supported my idea, I did not adjust my work. Of course, if I thought the feedback was reasonable, I adjusted my work according to the feedback.

*Requirements for the Quality and Function of Feedback.* In a previous study, aptitude treatment interaction effects (ATIE) was employed to survey the influences of feedback modes (specific and holistic) as well as the executive thinking styles of 58 computer science students on networked peer assessments. The influence of feedback obtained from online peer assessment was found to be related to individual differences (Lin et al., 2001). Students with highly developed executive thinking styles benefited more from online peer assessment activities because they were more willing to use advanced thinking and to adapt to new teaching strategies. In addition, specific feedback was found to be more beneficial to learning than holistic feedback. In the present study, we found that the learners also had expectations regarding the quality and quantity of the feedback they received.

The interviews revealed that the students expected to receive a large amount of high-quality feedback. The students condemned classmates who only provided holistic feedback or high scores with few concrete suggestions. In addition, the students referred to the specific feedback provided by others when modifying their work. They also complained about evaluators who only offered confirmation related feedback about their homework. Overall, the students valued specific feedback more highly than scores:

**Student F:** I don't think the score is very important, and I hope to receive more specific feedback that shows me how to improve my homework. In addition, when I received [feedback], I was disappointed at the unconstructive feedback provided by others.

**Student E:** In the first round of the networked peer assessment activity, I found that some students were lazy and wrote few suggestions without providing meaningful feedback. I hope to receive a large amount of feedback and suggestions. I also hope that my evaluators will point out as many of my defects as they can. For example, in the second round, I received some specific feedback, and two instances influenced me the most, really helping me to improve my slides for the final presentation. I would keep thinking of others' feedback for further improvement. For example, following the suggestions, I divided my research purpose into four different parts, which was not addressed clearly in the original version. Some of the feedback influenced me a lot. It pushed me to rewrite my homework in a clearer way.

*Modifications to Improve Readers' Understanding of the Work.* After receiving feedback, if the students found that the reviewers did not understand their work, they would rewrite it and provide more extensive explanations. Most students stated that they realized that they needed to modify their work after receiving feedback. Based on the feedback, the students sensed that the way in which they had written the homework and the way in which they had presented data were not comprehended by the readers as expected.

**Student E:** The feedback of others is a big help for improving my homework, because some of the ideas they provided had never occurred to me before I read them in this activity. In the beginning, I was very subjective and thought that I did my work quite well, but when others had some suggestions for my work, I realized that I should be more conscientious about my paper and that clarity is necessary in academic writing. After this process, I was totally changed.

**Student C:** In my second revision, I immediately corrected items that were difficult to understand in my first revision. For example, I found that the variables in one figure were unclear, so I changed it to make the figure clearer. I read the work of others before, and I found that the way they explained themselves in their articles was OK for my understanding and adopted the methods that those authors used in their work. However, after the peer assessment activity, I found that the evaluators could not understand what I wanted to express in my paper, so I changed the style of writing for my homework. I highlighted the key points, which made the paper easier to understand. I made modifications only because of the suggestions of others. I know now that my understanding is not equal to the understanding of others.

*Adopt a New Research Direction.* Approval from others tends to fortify the confidence of students regarding the manner in which they present their ideas in their homework. Students can adapt to the evaluators' feedback and generate new ideas or select new research directions.

**Student B:** In the beginning, I was unsure if my design was OK, but the affirmative feedback of others assured me that my decision was acceptable.

**Student B:** Some feedback indicated that I did not mention certain variables in my literature review. This means that my topic was developed without adequate support and that no evidence could support the variables I used in my paper. This feedback really influenced me a lot, and because of it, I modified my first research question. More importantly, I restructured my research. The feedback from my classmates gave me some ideas about how to modify my study and helped me to address a problem I did not notice. Without peer assessment, I would have had no motivation, and it would have been impossible for me to modify my work.

*Modifying One's Work to Obtain a Higher Score.* Some students described how their score was a motivating factor in modifying their articles. The students felt that only when they followed the evaluators' suggestions to



modify their homework would they receive a higher score in the next round. In addition, they were afraid of being criticized again. Therefore, the desire for a good score influenced some students to modify their work.

**Student A:** Other students commented on my topic, so I modified it substantially. I felt that if I did not adjust it according to the feedback, they would criticize this part again the next time.

#### **Student views regarding peer observation**

In the present paper, peer observation refers to the observations made in the review of the homework of their peers. The reflection prompted by reviewing the work of classmates may help students to judge and revise their homework in a better way. Students indicated two different views regarding the observation phase: very useful or not useful at all. Some students even viewed the peer observation as more helpful than the feedback received from suggestions. Students K and E did not consider peer observation useful because the reviewers, without knowing the background of the submitters, could only provide suggestions or scores based on their own understanding of the literal meaning or wording of the content. Peer reviewers were often skeptical of whether the explanations of others would persuade readers and evaluators. Hence, student evaluators usually only gave suggestions regarding ways to improve structure or format.

**Student K:** I think that the changes I made are more formal. Everyone has different solutions, and I do not have good insight into the submitter's solution and know little about their research background. Therefore, I can only know if the method they used could answer the research questions they proposed in advance, and I will not have better suggestions unless I already know more about the research background. Hence, I feel that feedback from observation is not helpful.

**Student E:** All of the statistical methods of submitters were reasonable. For example, when I evaluate a study on the concept of expertise, the only criticism from me will be the liability of the sample size. I will keep thinking about whether the participants they chose are not representative enough, and there should be something that needs to be studied in more depth in the future. I will also question the explanation in the text if there is something I cannot understand.

Most students that were interviewed (8 out of 10) reported that peer observation was very helpful. Four explanations may account for this. First of all, the students were able to learn various statistical methods in addition to what they had already adopted and employ the new methods in subsequent work. Second, they learned how to use APA format and how to structure an academic paper through the evaluation of others' work. Third, the students learned how to use better wording, clearer expressions, and organize content more effectively in their writing, which will be helpful to their academic training beyond the course itself. Fourth, they came to better understand their own difficulties with the project as a result of reviewing the homework of others.

**Student B:** I found that everyone clearly expressed their adopted statistical methods, and this was a great help to me. I noticed how they used methods that I do not use and saw how they explained why they used the method. Because of this, I changed my first research question. From observation, I found that another student's variance of data was similar to mine, and his method was better and more suitable than mine.

**Student D:** After observing the feedback and the work of others, I got a chance to think about areas I could improve; for instance, my wording did not necessarily express my ideas clearly, and I needed to add clearer explanations and draw a more integrated conclusion.

**Student F:** After reading the homework of my peers, I decided to rewrite my homework and make it complete. For example, I suggested that my classmates provide an overall and integral explanation in the final session, as this is what I always fail to do myself when completing statistics assignments.

**Student B:** I did not apply what I observed in the homework of others to modify my own homework, but the observation really made me reconsider which statistical methods I should use. Although I used different methods, I learned various ways to apply statistical methods by reviewing the homework of my peers.

In general, the students had positive opinions regarding peer observation. Although two students reported that

they received little help from peer observation, they still had a positive attitude toward the peer observation as to the way it helped them to modify the essay format. We can conclude that peer observation is helpful to different students in different ways.

### Student modification of their work

To measure changes in the work of students after two online peer assessment activities, a set of evaluative standards was established, by which to judge and categorize the students' work. All twelve students were given two opportunities to modify their work. Variable homework1 refers to the homework they had to submit in the middle of the semester. Variable homework2 refers to the modifications that the students made to their work according to the feedback they received from the peer assessment activity. Homework3 represents the final version of the homework that was submitted at the end of the semester, and the teachers gave final scores based on this version of the work. The amount and type of feedback applicable to the modifications in the students' homework are shown in Table 8.

**Table 8:** Feedback functions of modifications to the students' homework

Student	Homework2		Homework3	
	Feedback function	N	Feedback function	N
Student A	Expansion	5		
	Replace or rewrite	3	Replace or rewrite	1
Student B	Tuning	3		
	Expansion	2		
	Replace or rewrite	8		
Student C	Tuning	3		
	Restructuring	3		
	Expansion	6	Expansion	3
	Replace or rewrite	5	Replace or rewrite	8
Student D	Tuning	7	Tuning	1
	Expansion	1		
	Replace or rewrite	8	Replace or rewrite	2
Student E	Tuning	1		
	Expansion	3	Expansion	2
	Replace or rewrite	3	Replace or rewrite	1
	Tuning	3		
Student F	Restructuring	1		
	Expansion	11	Expansion	5
	Restructuring	The entire article	Replace or rewrite	1
Student G	Tuning		Tuning	6
	Expansion	3	Expansion	5
	Replace or rewrite	8	Replace or rewrite	6
	Tuning	3		
Student H	Restructuring	1		
	Expansion	3	Expansion	1
	Tuning	1	Replace or rewrite	3
Student I	Expansion	3		
	Replace or rewrite	2		
Student J	Expansion	7	Expansion	5
	Replace or rewrite	6	Replace or rewrite	6
	Tuning	7	Tuning	1
Student K	Expansion	1	Expansion	4

Student L	Replace or rewrite	7		
	Tuning	2	Tuning	4
	Expansion	13		
	Replace or rewrite	2		
	Tuning	2		
	Restructuring	1		

In this study, various feedback functions can be used to judge the modifications students make to their work. The revised work was considered good if it was influenced by feedback focused on the functions of tuning and restructuring. If the revised work was only influenced by the feedback associated with confirmation, expansion, or replace or overwrite, the modifications were considered to have taken place at a basic level.

We divided the students into two groups based on the feedback function counts from Table 8: work with advanced modifications and work with basic modifications. Of the twelve students, eleven of them performed advanced modification (see Table 9).

**Table 9:** Categorization of student modifications based on feedback function

Feedback function	Work with advanced modifications	Work with basic modifications
Number of students	11	1

To test the differences between advanced and basic modifications, a chi-square test was used to examine whether the difference between the samples and the normal population was significant. The value of  $\chi^2$  was 8.333\*\* ( $p < .01$ ), which indicates that the difference is statistically significant. Thus, after participating in the online peer assessment activities, the students made positive modifications to their work with the help of feedback from others. Based on the results of the chi-square test, the feedback provided in the online peer assessment activities had a positive influence on the students in the modification of their work.

## CONCLUSION AND DISCUSSION

This study analyzed the functions of various types of peer feedback and peer observation on changes in learning. The results of content analysis show that the students provided less feedback related to tuning and advanced functions in the second peer assessment than in the first peer assessment. However, the quality of student feedback improved from the first peer assessment to the second. Although the students adjusted their homework according to the feedback provided by their classmates, they did not always accept it fully. They also valued specific feedback more highly than scores; however, the desire to obtain high scores still motivated students to modify their articles. If the students found that the reviewers did not understand their work, they rewrote it and provided more extensive explanations. Furthermore, the students adopted the evaluators' feedback to generate new ideas or research directions. The students made positive modifications to their work with the help of feedback from others after participating in the online peer assessment activities. Most of the students had positive opinions regarding peer observation.

The findings of this research have several implications. First, increasing the number of peer assessments reduced the amount of advanced feedback provided. Advanced feedback (tuning and restructuring) can be viewed as a scaffold helping students to revise and reorganize their homework (Topping, 1998). As the abilities of learners increased, the scaffolding provided by their peers was progressively withdrawn, which led to a decrease in the amount of advanced feedback in the second peer assessment. The students made positive modifications to their work based on advanced feedback, which suggests that educators should encourage students to provide more feedback to their peers, and also encourage them to provide advanced feedback.

Second, most of the students had a good impression of peer observation. Some even stated that peer observation was more helpful than peer feedback. These findings complement those of Li, Liu, and Steckelberg's (2010), which indicated that there was a significant relationship between the quality of peer feedback and the quality of the students' own final projects. These results suggest that active involvement of students in assessing peers may play an important role in the online peer assessment environment. In peer observation, the assessor reviews, summarizes, clarifies, gives feedback, diagnoses misconceived knowledge, identifies missing knowledge, and considers deviations from the ideal. These are all cognitively demanding activities that could be beneficial for consolidating, reinforcing, and deepening the assessor's understanding. Although learning gains related to peer feedback and peer observation have been reported in this study, it remains unclear how these two roles contribute to the learning process. Future studies should further examine whether students benefit more from

assuming the role of assessor, being assessed, or both.

Finally, the students reported positive attitudes toward the feedback and expressed expectations regarding the amount and quality of feedback they received. They chose to focus on feedback with specific content when making modifications to their work and complained about evaluators who provided feedback without specific suggestions for modification. The process used in choosing useful feedback demonstrates the self-regulation mechanism of students: according to the feedback, the students searched for related information, verified its accuracy, and selected correct and useful portions of the feedback to modify their work. In light of these findings, instructors should encourage students to provide more specific and detailed feedback, which includes more suggestions to guide their peers in the process of revision (Lee & Chen, 2009; Liu & Lin, 2007). Developing the means to improve the specificity of peer feedback is an important issue to explore in the future.

Any generalization of these findings may be limited due to the small sample size of this study and is not necessarily applicable to learners in different educational settings or different cultural backgrounds. The characteristics of the “Statistics in Education and Psychology” differ considerably from those of other learning domains such as mathematics or computer science. Thus, the conclusions of our study cannot be generalized to other disciplines. Furthermore, the manner in which various forms of feedback influence various types of revisions (such as deep or more superficial revisions) was not explored in the present study. This issue requires further examination.

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