Improving pre-service teachers' ICT-integrated lesson design through formative peer feedback

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Abstract: Formative peer feedback plays a critical role in teachers' collaborative lesson design, which enables teachers to reflect on and continuously revise their lesson design by receiving and providing concrete comments and suggestions on how to improve tit. Past research has yielded mixed results on the effect of formative peer feedback on learning, partially because these studies used different types of formative peer feedback with different levels of specificity of the information provided in the feedback. This study examines the relationship between the type of formative peer feedback, the specificity of information provided in the formative peer feedback, and the quality improvement of the ICT-integrated lesson design by a group of pre-service teachers' in Singapore. The results show that the quality of ICT-integrated lesson design was significantly improved through the formative peer feedback. Furthermore, it is found that positive affective feedback and cognitive questioning feedback with specific explanation facilitated the improvement of the ICT-integrated lesson design whereas cognitive scaffolding feedback with specific explanation hindered the improvement of the ICT-integrated lesson design. The implications on how formative peer feedback affect pre-service teachers' ICT-integrated lesson design are discussed.
Keywords: Formative peer feedback, ICT integration, TPACK

1. Introduction

With the rapid development and diffusion of technologies, the integration of Information. Communication and Technology (ICT) to facilitate 21st century learning has become pervasive in educational institutes globally (Tondeur, van Braak, Sang, Voogt, Fisser, & Ottenbreit-Leftwich, 2013). The ICT integrated lesson design poses many challenges to teachers. Novice teachers often feel that they are not well-prepared to effectively use ICT for teaching and learning and ICT is under-used in their classrooms (Sang, Valcke, van Braak, & Tondeur, 2010). Previous studies have shown that a crucial factor affecting teachers' integration of ICT for teaching and learning is their experiences in technology-enhanced learning during their pre-service teacher training programs (Drent & Meelissen, 2008; Tseng, Cheng, & Yeh, 2019).

To prepare pre-service teachers for effective ICT integration, teacher education programs need to help them build Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2009). TPACK emphasizes the integrated use of technology, pedagogy and content knowledge for effective technology integration (Reyes Jr, Reading, Doyle, & Gergory, 2017). It aims at developing appropriate, context-specific strategies and representations for ICT-integrated lessons (Saubern, Urbach, Koehler, & Phillips, 2020). Several research studies have used TPACK as a design framework for pre-service teachers' ICT-integrated lesson design training (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010). Many teacher education programs have recognized the challenges associated with ICT-integrated lesson design using TPACK framework and proposed innovative teaching strategies (Angeli & Valanides, 2009). One of such strategies is collaborative lesson design (CLD) (Voogt et al.,, 2013). A large number of studies on collaborative learning have shown that formative peer feedback plays a critical role in enabling students to reflect on and continuously revise their work by receiving and providing concrete comments and suggestions on how to improve one another's work (Yang, 2011).

Formative peer feedback aims to help peers improve their work and performance which involves reflective engagement (Falchikov & Blythman, 2001). The effects of formative peer feedback have been substantially evidenced to vary with the type of feedback (Wisniewski, Zierer, & Hattie, 2020). Generally, there are two types of formative peer feedback: cognitive feedback and affective feedback (Nelson & Schunn, 2009). Cognitive feedback involves summarizing, specifying and explaining aspects of the work under review (Chen, Hwang, Lai, & Wang, 2020; Huisman, Saab, van Driel, & van den Broek, 2018; Veerman & Veldhuis-Diermanse, 2001). Cognitive feedback can be classified into three sub-categories: scaffolding, evaluation, and questioning (Hoey, 2017). Scaffolding type of feedback aims to provide suggestions to the identified problems in peers' work. Evaluation type

of feedback plays an evaluative role and aims to make decisions and assess the quality of peers' work. Questioning type of feedback aims to identify the problems and issue in peers' work. Feedback that provides suggestions (i.e., scaffolding) and identifies problems (i.e., questioning) are especially effective by facilitating students' interaction and knowledge construction (Kwon, Park, Shin, & Chang, 2019; Nelson & Schunn 2009). A recent study found that scaffolding was positively related to both learners' perception of the formative peer feedback, and their willingness to improve based upon the feedback, but was not directly related with their performance improved in academic writing (Huisman et al., 2018).

Affective feedback uses affective language to bestow praise ("well done") and criticism ("bad work"), or uses emoticons to convey emotion in text (Lu & Law, 2012). Affective feedback can be divided into two types: positive and negative affective feedback. Positive affective feedback is usually recommended and is found to be one of the most common features presented in the formative peer feedback (Cho, Schunn, & Charney, 2006). There are many studies on teachers' praise of students (Kwon et al., 2019), but few studies examined the praise given by peers. Furthermore, there are mixed results on the effect of positive affective feedback on students' learning improvement. Some studies showed the benefits of positive affective feedback by improving student's learning (Duijnhouwer, 2010) whereas other studies found that positive affective feedback was ineffective for improving students' learning, especially when the required task is cognitively demanding (Kwon et al., 2019).

One research gap identified from the past research is that they examined different types of formative peer feedback without identifying the specific level of feedback, which might explain the mixed results on the effect of formative peer feedback. The specificity of the feedback concerns the contextual relevance and the precise and appropriate amount of information provided in the feedback. Researchers argued that more specific feedback was more effective than general feedback for students' learning (Chen et al., 2020; Ferris, 1997). It is assumed that the level of specificity of the feedback moderate the effects of the type of formative peer feedback in learning improvement. Taken together, the effects of formative peer feedback on improvement of work vary with the types of feedback as well as the levels of specificity of task-related information provided in the formative peer feedback.

There is hardly any research in the literature investigating how formative peer feedback affect pre-service teachers' improvement on CLD with TPACK. This study examines the relationship between the type and the level of specificity of the formative peer feedback and the improvement of the ICT integrated lesson design for pre-service teachers. This study has three research questions: (1) Does formative peer feedback improve the quality of pre-service teachers' ICT integrated lesson design? (2) Is the type of formative peer feedback related to the improvement of pre-service teachers' ICT-integrated lesson design? (3) Does the level of specificity of the formative feedback moderate the relationship between the cognitive and affective peer feedback and the improvement of pre-service teachers' ICT-integrated lesson design?

2. Method

2.1 Participants and learning context

40 pre-service Chinese language teachers (39 females) studying at the Nanyang Technological University were enrolled.. Ten of them were aged from 20 to 25; 19 were aged from 26 to 30; and 11 were aged above 30. The lecturer had four years of experiences in both pre-service and in-service teacher professional development, and can use technology effectively for teaching and learning.

The learning task was to collaboratively design Technology-Enhanced Learning (TEL) for Chinese teaching and learning. The study was carried out in where each participant was equipped with a computer. The participants were grouped into 10 groups with 4 members. Before the CLD activity, the TPACK was introduced , the design principles for TEL and CLD, and the strategies of formative peer feedback. After the introduction, a 1.5-hour collaborative lesson design activity was conducted once a week for three weeks. The online platform used for participants' CLD was Padlet, a commonly used online collaborating tool for Singapore teachers. In the CLD activity, the participants worked in groups to develop an ICT-integrated lesson design and posted it on the group space at Padlet (30 minutes). Then they visited other groups' working space to provide formative feedback (30 minutes) using the commenting feature of the platform. After that they went back to own group space to improve the lesson design by addressing comments from other groups (30 minutes). Collaborative lesson design activities of week 2 and 3 were the same as week 1.

2.2 Data collection

As this study focuses on the effects of formative peer feedback on the improvement of pre-service teachers' ICT-integrated lesson design, we collected the pre-service teachers' ICT-integrated lesson design before the formative peer feedback and after the formative peer feedback, as well as the formative peer feedback provided and received. In total there were 60 lesson plans and 256 posted comments as formative peer feedback collected.

2.3 Research instruments

2.3.1 Coding of ICT-integrated lesson design

The unit of analysis of ICT-integrated lesson design is one group's completed lesson design before and after the formative peer feedback activity. The quality of the ICT-integrated lesson design was coded using a TPACK coding scheme. TPACK is a well-acknowledged and dependable guide to evaluate the quality of TEL design (Koh, Chai, Benjamin, & Hong, 2015). The ICT-integrated lesson design was coded from seven TPACK domains as defined by Koehler and Mishra (2009). TPACK was measured by a scale where 10 being the lowest quality and 50 being the highest quality. Two trained coders coded the data. The inter-coder reliability was high (Cronbach's alpha = 0.96).

2.3.2 Coding of formative peer feedback

The formative peer feedback was coded by adapting the existing peer assessment and feedback coding schemes (Chen et al., 2020; Veerman & Veldhuis-Diermanse, 2001). The unit of analysis was one commenting post. Each commenting post was categorized into cognitive and affective dimension. As mentioned, cognitive feedback consists of scaffolding, evaluation and questioning, and affective feedback includes negative affective feedback and positive affective feedback. Furthermore, each peer comment was coded on the level of specificity which consists of three levels: low, medium, and high level. The formative peer feedback was coded by two trained coders. In terms of coding of the type of feedback, the inter-coder reliability was moderate (Cohen's Kappa = 0.543). With regards to the level of specificity, the inter-coder reliability test results indicted moderate and substantial agreement (Cohen's Kappa = 0.576 for positive affective feedback, 0.681 for scaffolding, 0.544 for evaluation, and 0.571 for questioning, respectively).

3. Results

3.1 Quality of ICT-integrated lesson design, before and after the formative peer feedback

To address the first research question, Wilcoxon test was applied to investigate whether the quality of ICT-integrated lesson design improved after the formative peer feedback as data did not follow normal distribution. We found that the quality of lesson design after the formative peer feedback (M = 13.76, SD = 15.00) was significantly higher than that before the formative peer feedback (M = 10.23, SD = 15.30) (Z = 2.82, p < .05).

3.2 Type and specificity level of the formative peer feedback

Table 1 shows the number and percentage of formative peer feedback by type and level of specificity. It is found that there was no negative affective feedback in the formative peer feedback provided and received. 48% of the formative peer feedback were at low level of specificity, while feedback with medium level specificity accounted for 32% of all feedback, followed by feedback with high level specificity (21%).

Table 1. *Frequency of formative peer feedback, by type and level of specificity*

Category	Low level (Numbers. & %)	Medium Level (Numbers. & %)	High level (Numbers. & %)
Positive affective feedback	130 (64%)	35 (17%)	38 (19%)
Cognitive feedback	156 (39%)	158 (40%)	83 (21%)
Scaffolding	57 (32%)	82 (46%)	40 (22%)
Evaluation	23 (40%)	10 (17%)	25 (43%)
Questioning	76 (48%)	66 (41%)	18 (11%)

Note: Cognitive feedback is classified into three categories: Scaffolding, Evaluation, and Questioning

3.3 Relationship between peer feedback and improvement of ICT-integrated lesson design

3.3.1 Correlation analyses

Correlation analyses were employed to address the second and third research questions. We found that the relationship between formative peer feedback and the improvement of ICT-integrated lesson design was moderated by both the type and the specificity level of the formative peer feedback. Specifically,

low level specificity positive affective feedback was negatively related to the improvement of the ICT-integrated lesson design, whereas medium level specificity positive affective feedback was positively related (r = -0.44, p < .05; r =0.44, p < .05, respectively). Low level specificity evaluation cognitive feedback was positively related to the improvement of the lesson design (r = 0.40, p < .05). Medium level specificity questioning cognitive feedback was positively related to the improvement of the ICT-integrated lesson design (r = 0.48, p < .05).

3.3.2 Stepwise regression analyses

To further investigate how the type and specificity level of formative peer feedback affected the improvement of ICT-integrated lesson design, stepwise regression analyses were conducted to identity the significant predictors for the improvement of ICT-integrated lesson design (i.e., TPACK). A total of three specificity levels of formative peer feedback were included in the regression model. Regression analyses results showed that questioning with medium level specificity positively predicted the improvement of TPACK of the lesson design ($\beta = 0.99^{**}$, p < .01), whereas the high level specificity negatively predicted the improvement ($\beta = -0.54^{*}$, p < .05). Scaffolding type of cognitive feedback with medium level specificity negatively predicted the improvement of lesson design ($\beta = -0.58^{*}$, p < .05).

4. Discussion and conclusion

This study investigates the relationship between formative peer feedback and pre-service teachers' improvement on ICT-integrated lesson design. This study found that the quality of ICT-integrated lesson design was significantly improved after the formative peer feedback. Furthermore, the relationship between formative peer feedback and the improvement of ICT-integrated lesson design was moderated by both the type and the specificity level of the feedback. The results suggest that questionings type of cognitive feedback with explanation was the contributing factor of the improvement of ICT-integrated lesson design; few numbers of scaffoldings with explanation helped improve pre-service teachers' ICT-integrated lesson design. The findings confirm the role of formative peer feedback in improving pre-service teachers' CLD in an authentic classroom setting.

Surprisingly, scaffolding type of cognitive feedback negatively predicted pre-service teachers' improvement on ICT-integrated lesson design, in particular, peers' scaffolding with explanation was related to the improvement of lesson design. One possible explanation on the negative effect of peers' scaffolding type of cognitive feedback is that scaffolding was intended to provide suggestions to the identified problems in peers' work or performance (Chen et al., 2020; Huisman et al., 2018; Veerman & Veldhuis-Diermanse, 2001). Therefore, based on scaffolding type of cognitive feedback provided by others, pre-service teachers could directly get the suggestions to the identified problems in peers' work or performance without deeply think how to improve their lesson design. For example, one scaffolding type of cognitive feedback example was "*Please provide explanations on words/Chinese phonetic alphabet, and provide scaffolding on given pictures.*" With this feedback, the group knew clearly how to improve their lesson design.

Regarding positive affective feedback, feedback with low level specificity negatively related the improvement of ICT-integrated lesson design whereas feedback with medium level specificity positively related the improvement of the lesson design. Some studies have shown that compared with students not receiving formative peer feedback, the leaners' performance was not improved when they received pure positive affective feedback (Kwon et al., 2019). For example, one positive affective feedback with low level specificity was "This is very interesting." The feedback did not include any concrete information related to the lesson design itself. Therefore, on one hand pre-service teachers might not get any concrete idea on how to improve their lesson design. On the other hand, they might consider their lesson design as perfect work, which did not need further revision. Unlike the feedback with the low level specificity, the positive affective feedback with medium level specificity included information about their lesson design on top of expressing positive affection. For example, one positive affection feedback with medium level specificity was that "This is good to combine students' prior experience." The group received this feedback further elaborated the part of individualized teaching in their lesson design according the feedback.

Regarding evaluation type of feedback, the level of specificity of feedback did not predict the improvement of the ICT-integrated lesson design. One possible explanation is that the frequency of evaluation type of cognitive feedback was relatively less than other types of feedback. In this study the number of peer evaluation type of feedback was 58 which was less than 10% of the total number of formative peer feedback (600). As a consequence, the evaluation type of cognitive feedback did not significantly affect the improvement of the ICT-integrated lesson design.

As questioning type of cognitive feedback, this study found that questioning with explanation was a significant predictor for the improvement of the ICT-integrated lesson design. This result echoes previous studies' findings on formative peer feedback (Kwon et al., 2019; Nelson & Schunn, 2009). Several studies highlighted questioning as a key strategy in promoting students' improvement (Kwon et al., 2019; Zhang, Lundeberg, McConnell, Koehler, & Eberhardt, 2010). For example, Zhang et al. (2010) found that soliciting idea and reframing idea questions helped students initiate their thinking, clarifying idea questions provided the students with opportunities to elucidate their thinking, and pushing for elaboration and checking for interpretation questions deepened the students' thinking. Interestingly, this study also found that peers' questioning with lots of explanations negatively predicted the improvement of the lesson design. The theory of zone of proximal development (ZDP) developed by Vygotsky (1929) provided a possible explanation for this result. ZDP refers to the distance between the actual developmental level as determined by individual problem-solving and the level of potential development as determined through problem-solving under guidance or in collaboration with more capable peers (Bruner, 1984). According to the theory of ZDP, peers' questioning type of feedback is effective only when it is higher than pre-service teachers' actual developmental level, and be lower than the level of potential development. When questioning type of feedback was too simple or too complicated, it might be either lower than pre-service teachers' actual developmental level or higher than their potential developmental level in ICT-integrated lesson design. Therefore, peers' less and too specific questionings did not facilitate pre-service teachers' improvement in ICT-integrated lesson design, and such questioning type of feedback might even hinder their improvement in lesson design.

One limitation of the study was that the series statistical analyses used may not be able to explain the mechanism of how the lesson design was improved. More qualitative studies (e.g., uptake analysis, transitivity analysis) are needed to examine how pre-service teachers improve the lesson design through the formative peer feedback (van de Pol, Mercer, & Volman, 2019).

Despite the above limitations, the findings of this study contribute to the literature on pre-service teachers training of ICT-integrated lesson design and formative peer feedback for learning and improvement. The power of formative peer feedback to improve students' performance or work has been recognized in earlier research (Gikandi & Morrow, 2016), but there has been little research on how formative peer feedback affect pre-service teachers' improvement on ICT-integrated lesson design, and how the types as well as specificity of co-design related information moderated the effects of formative peer feedback. This study is the first to examine formative peer feedback with different types and levels of specificity.

In conclusion, this study found that formative peer feedback helps pre-service teachers' improvement on ICT-integrated lesson design and this effect varied both with the types as well as with the levels of specificity of task-related information of the feedback. In specific, positive affective feedback and questioning with explanation type of cognitive feedback facilitated pre-service teachers' improvement in lesson design. On the contrary, scaffolding with explanation hindered pre-service teachers' improvement on ICT-integrated lesson design. The results inform how formative peer feedback affect pre-service teachers' improvement ICT-integrated lesson design. This study has practical implications for educational practices in collaborative lesson design: peers are encouraged to generate more positive affective feedback and questioning type of feedback with explanations.

Acknowledgements

We would like to thank all the people who prepared and revised previous versions of this document. This study was funded by the Education Research Funding Programme, National Institute of Education (NIE), Nanyang Technological University, Singapore, project no. OER 17/19 CWL. The views expressed in this paper are the author's and do not necessarily represent the views of the host institution.

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