Instructional scaffolds for learning from formative peer assessment: effects of core task, peer feedback, and dialogue

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Current research themes

(computer-supported) collaborative learning; cognitive and communicative processes in knowledge co-construction; development, assessment, and training of scientific thinking skills; teacher education; cognitive, social, and motivational resources in Higher Education

Most relevant publications

Deiglmayr, A., & Schalk, L. (2015). Weak versus strong knowledge interdependence: A comparison of two rationales for distributing information among learners in collaborative learning settings. *Learning and Instruction, 40,* 69 – 78. DOI: 10.1016/j.learninstruc.2015.08.003

Deiglmayr, A., Paus, E., McCall, C., Mullins, D., Berthold, K., Wittwer, J., Krämer, N., & Rummel, N. (2013). Towards an integration of the learning perspective and the communication perspective in computer-supported instructional communication. *Journal of Media Psychology, 2* (4), 180-189. DOI: 10.1027/1864-1105/a000101

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Abstract

Formative peer assessment is an instructional method that offers many opportunities to foster students' learning with respect to both the domain of the core task and students' assessment skills. The contributions to this special issue effectively address earlier calls for more research into instructional scaffolds and the implementation of dialogic features in formative peer assessment. However, open issues remain regarding the role of assessment criteria, the benefit of formative peer assessment for transferable knowledge and skills, the role of meta-cognitive and cognitive processes in the provision and reception of peer feedback, and the proposed benefit of more interactive forms of formative peer assessment. Addressing the latter issue in particular, a framework of three dimensions of increasing interactivity is proposed in order to guide future research. These three dimensions comprise the learner's engagement with the core task (low interactivity), the provision and reception of peer feedback (medium interactivity), and the learner's engagement with argumentation, tutoring, and co-construction in dialogue with peers (high interactivity).

1. Instructional scaffolds for supporting learning from formative peer assessment

As already pointed out in the editorial, the eight contributions to this special issue address three major sources of variance in the processes and outcomes of formative peer assessment (Strijbos & Wichmann): learner characteristics, domain and task characteristics, and instructional scaffolds. In honor of the title of this special issue, I will focus my commentary on instructional scaffolds for supporting learning from formative peer assessment.

In formative peer assessment, students receive an assessment task (i.e. assessing peer products and providing peer feedback) in addition to a core task (e.g., writing an essay, constructing a model, or creating some other kind of product). The core task and the assessment task are intertwined, and both offer multiple learning opportunities (Reinholz, 2016). As a consequence, potential learning outcomes of formative peer assessment comprise students' knowledge and skills in the domain of the core task as well as their peer-assessment and peer-feedback skills (Gielen, Peeters, Dochy, Onghena, & Struyven, 2010; Sluijsmans, Brand-Gruwel, Van Merriënboer, & Martens, 2004; Van Zundert et al., 2012). Its dual nature makes formative peer assessment a cognitively quite demanding learning task (Van Gennip, Segers, & Tillema, 2009; Van Zundert, Könings, Sluijsmans, & Van Merriënboer, 2012). Instructional scaffolds for formative peer assessment therefore aim to support students in acquiring and consolidating knowledge and skills while tackling the combined demands of the core and the assessment task (Hoogeveen & Van Gelderen, 2013; Van Zundert et al., 2010).

Instructional scaffolds are thus an interesting factor from the perspective of the instructor / practitioner, and have also become a recent focus in research on peer assessment (Hoogeveen & Van Gelderen, 2013; Van Zundert, Sluijsmans, & Van Merriënboer, 2010). Indeed, all eight contributions to this special issue, even those that also explore learner or domain and task characteristics, employ instructional scaffolds for fostering learning from formative peer assessment. In the following, I will briefly review the contributions with a focus on these

instructional scaffolds. To facilitate comparisons across studies, I will identify the phase(s) of formative peer assessment -- i.e. Task Performance, Feedback Provision, Feedback Reception, and Revision (Kollar & Fischer, 2010) -- that were a) realized in the design of the study, and b) targeted by the main instructional scaffold(s). Each review concludes with what I consider the most important insight to be gained from the study with regard to the design of effective instructional scaffolds for fostering learning from formative peer assessment. Subsequently, I will offer an integration of the papers' findings organized around open issues – including the question of the extent to which formative peer assessment can be viewed as a collaborative learning activity. Finally, I will propose a framework of learning processes and instructional scaffolds addressing three dimensions of increasing interactivity in formative peer assessment. These three dimensions comprise the learner's engagement with the core task (low interactivity), the provision and reception of peer feedback (medium interactivity), and the learner's engagement with argumentation, tutoring, and co-construction in dialogue with peers (high interactivity).

2. The contributions to this special issue: What have we learned?

Alqassab, Strijbos, and Ufer employed the Feedback Provision phase of formative peer assessment in a university course for pre-service mathematics teachers. The main instructional scaffold consisted of a task-specific peer-feedback training intervention that taught students how to provide high-quality peer feedback on a specific type of geometric construction task. The targeted learning outcomes were students' peer feedback provision skills and their beliefs about their ability to provide peer feedback. The quality of the provided peer feedback (but not students' peer feedback beliefs) indeed increased after the training. Since there were no comparison conditions, it is unclear which aspects of the training (which included a combination of verbal instructions, feedback provision prompts, evaluation rubrics, worked examples, and feedback practice) contributed to its effectiveness and to what degree.

Nevertheless, the results indicate that suitable instructional scaffolds can effectively improve peer feedback skills. In addition, the authors plausibly argue that effective instructional scaffolds need to be task-specific.

Berndt, Strijbos, and Fischer investigated the Feedback Reception and Revision phases of formative peer assessment in a laboratory setting. Their main research interest concerned the mindful cognitive processing of received peer feedback. The recruited psychology students all received the same essay written by a fictitious student, together with fictitious peer feedback. Subsequently, they were asked to revise the essay. The instructional scaffolds were the features of the received peer feedback. These were experimentally manipulated in a 2×2 design that crossed the type of peer feedback (general vs. specific) with the competence of the fictitious peer (communicated directly to the learners as either high or low). Possibly due to the small sample size, neither factor was found to affect students' performance on two objective outcome measures (performance during revision, and recall of feedback) or the mindful cognitive processing of feedback. As a further limitation, because students received an essay from another (fictitious) student, it is plausible to assume that they processed the peer feedback somewhat differently than if they had written the essay themselves. Nevertheless, a remarkable innovation of this study is the operationalization of mindful cognitive processing by a combination of eye-tracking measures and analyses of students' revisions and their feedback recall.

Tsivitanidou, Constantinou, Labudde, Ropohl, and Rönnebeck studied all four phases of formative peer assessment in the context of Physics instruction in secondary education. The core task was to design a scientific model of additive/subtractive color mixing, following a series of hands-on experiments on the same topic. The students worked in dyads on the core task during Task Performance and Revision, also discussing the received peer feedback and whether and how to implement it for their joint product. During Feedback Provision, each student worked individually on the assessment task, with both members of one dyad providing

feedback to both members of another dyad (intergroup peer assessment). During all phases, the authors implemented various instructional scaffolds for both the core task and the assessment task. They did not use a (quasi-)experimental design to test the effects of specific instructional scaffolds, but focused instead on in-depth analyses of students' products, feedback messages, and revisions. The quality of students' models increased from before until after Feedback Reception and Revision. The content analyses of models, feedback, and interview data indicate that students benefited not only from providing and receiving feedback, but also from being exposed to high-quality products designed by their peers. Thus, peer products, in particular high-quality ones, can also serve as instructional scaffolds.

Rotsaert, Panadero, and Schellens studied the Task Performance, Feedback Provision, and Feedback Reception phases of formative peer assessment in a university-level course on Educational Science. The core task, on which students worked collaboratively in small groups, was to plan a workshop on a topic of Instructional Design. The instructional scaffolds explored by the authors targeted the Feedback Provision phase. The students individually assessed the workshop presentations of all other groups, i.e. each student provided peer feedback multiple times. Feedback Provision was anonymous during the first half of the course and non-anonymous during the second half. As there was no control condition, the effects of anonymity versus non-anonymity may have been confounded with effects of time and practice. Thus, the study's findings are probably best interpreted as resulting from the combined effects of fading anonymity, repeated practice, and the specific instructional scaffolds for Feedback Provision: Students received peer feedback guidelines and filled in an assessment rubric for each feedback round. The aggregated rubric scores and feedback messages were displayed to and discussed by the whole class; the teacher further facilitated this discussion with reflective questions. The results from this carefully scaffolded orchestration of formative peer assessment show that students indeed provided more elaborated feedback and felt more competent as peer assessors over time.

Leenknecht and Prins employed all four phases of formative peer assessment in primary education classrooms. The students' core task was to create an informative brochure on the topic of climate change. The instructional scaffold designed by the authors, an assessment-criteria training intervention, focused on Feedback Provision. The training included examples of brochures with different levels of quality, and whole-class discussions of assessment criteria and standards for producing an informative brochure. The results from the comparison with an untrained control condition show that the training indeed increased students' knowledge about relevant assessment criteria. The authors did not analyze whether the students also provided more criterion-referenced feedback to their peer. However, they showed that compared to untrained students, trained students were more likely to produce positive verifications in what they termed an 'authoritative' (i.e., summative) feedback style. The authors suggest that knowledge about criteria might have led students to adopt a summative rather than a formative perspective. Thus, their study reminds us that increasing awareness of assessment criteria may not always be a beneficial instructional scaffold for peer-feedback provision.

Peters, Körndle, and Narciss implemented the Task Performance, Feedback Provision, and Revision phases of formative peer assessment in the context of vocational education. Students' core task was to generate and revise a draft of a technical plan for producing a metal workpiece. In addition, they provided feedback on a fictitious peer solution that contained typical errors. The main instructional scaffold was a task-specific Formative Assessment Script (FAS) provided during Feedback Provision. The script structured the task into smaller units, specified assessment criteria, and provided feedback prompts. The provision of peer feedback was complemented by the generation of 'internal feedback', i.e., self-assessment, which was also supported by the FAS. In a quasi-experimental 2x2 design, students worked either with or without the FAS, and provided peer feedback either before or after self-assessing and then revising their own product (peer feedback provided after self-assessment was, however, not further analyzed). Neither the provision of peer feedback nor the FAS had an effect on the

quality of the revised planning draft. The FAS was beneficial for the quality of provided peer feedback, but less so for the quality of the students' self-assessments. No beneficial effects of peer-feedback provision prior to self-assessment could be observed. As suggested by the authors, the planning task might have been too complex for students to draw helpful parallels between the fictitious peer draft and their own draft. In summary, the results indicate that the FAS was an effective instructional scaffold for generating peer feedback, was less helpful for supporting self-assessment, and did not improve core task performance.

Voet, Gielen, Boelens, and DeWever implemented all four phases of formative peer assessment in the context of an academic writing assignment (writing a research abstract) in a university-level course in Educational Science. In a 2x2 design, two instructional scaffolds were tested during Feedback Provision: the presence/absence of a feedback request (i.e., the assessee was asked to hand in a specific feedback request together with the task product), and the presence/absence of a content checklist to which assessors could refer when evaluating their peer's product. Independently of the research condition, all students were additionally scaffolded by a feedback template that provided a list of criteria for evaluating the task product. Three cycles of peer feedback were realized. The first cycle served to familiarize students with the peer-feedback procedure and the feedback template, and the second cycle to familiarize them with the additional scaffolds. The first cycle was also used as a baseline for assessing the change in feedback content over time (between cycles 1 and 3). The results show that the presence of a feedback request, but not the availability of the content checklist, had beneficial effects on feedback quality. Thus, prompting authentic, specific feedback requests was an effective instructional scaffold for enhancing the quality of elicited peer feedback.

Wichmann, Funk, and Rummel employed formative peer assessment in a university-level course in Educational Science. They realized the Task Performance, Feedback Reception, and Revision phases. The students' core task was to write an essay on a topic from Developmental

Psychology. The feedback they received pointed out typical writing errors (e.g. nested sentences, filler words). To ensure comparability, this "peer" feedback was not actually provided by a peer, but consisted of semi-standardized comments provided by trained tutors. The instructional scaffold consisted of a table in which students listed and evaluated the received feedback comments, and decided whether and how to use them in their revision. The aim of this "sense-making support" tool was to support students' self-regulation in processing the received feedback and improving their essay. The targeted outcomes were the number of feedback-based changes during revision (feedback uptake), and increases in students' revision skills (problem detection and problem correction with regard to typical writing errors) assessed in a pre-posttest design. The results show that the sense-making tool was partially beneficial for students' feedback uptake and revision skill.

3. Open issues in formative peer assessment: Where should we be going?

The findings of the eight contributions to this special issue can be integrated and contrasted along four important open issues, pointing towards future themes in research on learning from formative peer assessment.

3.1. How helpful are assessment criteria for Feedback Provision?

Five of the contributions to this special issue focused on instructional scaffolds for Feedback Provision, targeting, as outcomes, learners' ability to provide adequate, elaborated and justified feedback. Two studies explored training interventions as instructional scaffolds: Alqassab et al. developed a task-specific peer-feedback training intervention for providing peer feedback on a geometric construction task, and Leenknecht and Prins employed a training intervention in which learners were supported in generating and internalizing assessment criteria. In both studies, learners internalized a set of criteria during the training before providing formative peer assessments in a subsequent phase. The three remaining studies tested the effects of checklists or rubrics that were provided during Feedback Provision without prior training: Peters et al.

provided assessors with a detailed, task-specific formative assessment script, Voet et al. provided assessors with a task-specific content checklist, and Rotsaert et al. provided assessors with a detailed assessment rubric. Thus, in line with research-based recommendations for the practical implementation of peer assessment and peer feedback (Topping, 1998; Nicol & Macfarlane-Dick, 2006), all five groups of authors assume that formative peer assessment will result in higher-quality (i.e., more adequate, elaborated, and justified) feedback when assessors are aware of relevant assessment criteria. However, their results show that this is not always the case: Based on their findings with primary school children, Leenknecht and Prins warn that knowledge of assessment criteria might lead students to perceive peer assessment as summative rather than formative assessment, resulting in a more authoritative feedback style and less elaborated feedback. Furthermore, Voet et al. found no beneficial effects for their content checklist; instead, the presence of a personal feedback request was more effective for eliciting high-quality peer feedback. Finally, the findings obtained by Peters et al. remind us that beneficial effects of detailed task-specific criteria on peer feedback provision do not necessarily translate into better self-assessment or improved task performance. Thus, while peer assessors doubtlessly need to be aware of relevant feedback criteria, awareness alone is not sufficient for their ability to provide high-quality peer feedback. It appears that Feedback Provision can be improved if – in addition to awareness about relevant assessment criteria – peer assessors also have task-specific knowledge about how to support the reasoning of their peers (e.g., Alqassab et al.) as well as peer-specific knowledge about the problems on which their peer would like to receive feedback (e.g., Voet et al.).

3.2. Does formative peer assessment improve performance and learning in the core task?

The majority of studies in this special issue targeted and assessed students' performance in the assessment task, i.e., the quality of the peer feedback they provided. However, four studies also

assessed students' performance in the core task as dependent variable. Berndt et al. assessed students' performance in the Revision phase, but found no effects of the type of feedback students had received on the quality of their revision. Tsivitanidou et al. examined changes in students' models of color mixing as a result of both providing and receiving peer feedback. Their results indicate that learners benefit with regard to their own task performance when they are exposed to high-quality peer solutions during the peer feedback process. Peters et al. studied the change in students' performance on the core task, but did not find beneficial effects either for providing peer feedback or for working with a formative assessment script. Finally, Wichmann et al. showed an increase in students' problem detection skill in a new writing task serving as post-test after receiving peer feedback. Combined, these four studies remind us that, in practice, the peer-feedback method is typically used in order to enhance students' learning in the core task, i.e. the task that is the object of the peer-feedback process. Thus, the effectiveness of instructional scaffolds for peer feedback should ultimately be judged not only based on their effects on the peer feedback process itself, but also on learners' acquisition of knowledge and skills in the core domain (e.g., academic writing, scientific modeling, geometric construction, designing a product). Ideally, such learning should be inferred from enhanced performance in the core task, but should also be visible from post-test measures requiring some transfer from the original core task (as shown, for example, in the study by Wichmann et al.). It is possible that such transfer effects occur even in the absence of enhanced performance during the original learning task (cf. Schwartz, Bransford, & Sears, 2005). Similarly, if the aim is to enhance students' assessment skills by involving them in formative peer assessment, the benefits should ideally be demonstrable in future assessment tasks. More research is needed to examine the factors that mediate and moderate the effect of formative peer assessment on students' learning with regard to the core task and with regard to improved assessment skills. Such research should ideally employ analyses of the content and quality of the formative peer assessment process together with results from pre-, post- and transfer tests.

3.3. What is the role of mindful cognitive processing of peer feedback?

One factor that very likely contributes to students' learning from formative peer assessment is the depth and elaboration of their processing of peer feedback — i.e. the mindful cognitive processing of peer feedback (Bangert-Drowns, Kulik, C., Kulik, J., & Morgan, 1991; Bolzer, Strijbos, & Fischer, 2015). Such mindful cognitive processing of received peer feedback cannot be taken for granted, even if the provided feedback is of high quality. Yet, research on how to scaffold and how to assess mindful cognitive processing of peer feedback is still in its infancy (Bolzer et al., 2015). In this special issue, the instructional scaffolds designed by Berndt et al. and Wichmann et al. aim to prompt mindful cognitive processing, in particular the application of metacognitive strategies such as monitoring and planning. As mindful cognitive processing cannot be directly observed, the authors' methodological solutions for inferring mindful cognitive processing from other relevant process and outcome measures constitute an important contribution to the literature on learning from receiving peer feedback. Berndt et al. operationalized mindful cognitive processing by means of eye-tracking data, whereas Wichmann et al. assessed mindful cognitive processing via students' responses in the sense-making tool, and in the form of feedback uptake in students' revisions. The question of how cognitive processing of peer feedback can be inferred from students' overt behavior and/or the products of their learning processes is currently fueling new methodological developments in research on formative peer assessment (e.g., Bolzer et al., 2015; Van der Pol, van den Berg, Admiraal, & Simons, 2008). Improved methods for assessing the cognitive processing of peer feedback will help researchers to empirically examine its assumed mediating role in students' learning from formative peer assessment.

3.4. Where is the collaboration in formative peer assessment?

The learning situation in formative peer assessment is inherently social (Van Gennip et al., 2009), and instructional scaffolds often emphasize collaborative activities such as helping (e.g.,

helping a peer with his/her text), sharing (e.g., sharing ideas, comments, evaluations), or responding (e.g., responding to a peer's requests for help, responding to critical questions from a peer). Formative peer assessment is therefore sometimes addressed as a collaborative learning activity (Kollar & Fischer, 2010; Strijbos, Ochoa, Sluijsmans, Tillema, & Segers, 2009; Van Gennip, Segers, & Tillema, 2010). Likewise, the title of this special issue also references the 'collaborative nature' of formative peer assessment. Nevertheless, formative peer assessment is also distinctly different from typical collaborative learning activities with regard to the amount of interactivity that it typically involves. In practice, formative peer assessment is often limited to the exchange of products and feedback messages between individual peers, with little room for two-way discussion, negotiation, or joint problem-solving (Kollar & Fischer, 2010; Strijbos et al., 2009; Topping, 1998). However, a two-way, multi-turn dialogue in which learners elaborate on, critique, or expand one another's reasoning and ideas, is a hallmark of collaborative learning (Dillenbourg, 1999). In line with the broader literature, I will refer to such collaborative, dialogic co-construction as "interactive" (Chi & Wylie, 2014).

While formative peer assessment is inherently social, the extent to which it can also be interactive, and thus truly collaborative, strongly depends on the concrete design of the formative peer-assessment process. Researchers studying the learning processes in formative peer assessment have recently begun to respond to the call to enhance interactive dialogue in formative peer assessment, thus opening up opportunities for mutual knowledge co-construction and tutoring (Kollar & Fischer, 2010; Strijbos et al., 2009). Of the eight papers in this special issue, four realized some degree of interactivity, i.e. communication beyond the one-way exchange of feedback. The most notable example is the study by Rotsaert et al., who realized open, instructor-guided classroom discussions following the provision and aggregation of individual student peer feedback on each group's performance. Leenknecht and Prins also employed whole-class discussions of assessment criteria as part of their assessment criteria training. The learner dyads in the study by Tsivitanidou et al. were able to discuss the feedback

they had received from their peers, as well as the peer solutions on which they themselves had provided feedback, deciding together on whether and how to adapt their model during Revision. In addition, feedback criteria were discussed in the class prior to Feedback Provision. Finally, in the study by Voet et al., assessors provided feedback in response to specific requests from a peer, thus increasing the interactivity of peer communication at least to some degree. None of these four studies contrasted peer assessment with dialogic features to peer assessment without such features – which would be necessary in order to draw any causal inferences regarding the effects of introducing more dialogic features into peer assessment. There are plausible arguments that strengthening the collaborative aspects of formative peer assessment may enhance its learning potential (Kollar & Fischer, 2010; Strijbos et al., 2009). However, in order to clarify to what extent formative peer assessment benefits from becoming more dialogic in nature, we need more studies employing controlled (quasi-)experimental designs, as well as research exploring links between process and outcome measures in formative peer assessment. In the following, I propose a framework of three dimensions of increasing 'collaborativeness', or interactivity, to guide such research.

4. Learning from engaging with the core task, peer feedback provision and reception, and dialogue in formative peer assessment

Providing and receiving peer feedback is an inherently social and interpersonal, though not necessarily interactive, process. In fact, many learning processes that are at the core of formative peer assessment do not require highly interactive dialogue between peers, but arise from the relatively restricted exchange of products and feedback of only medium interactivity. Other learning processes may arise from elaborated task materials (e.g. checklists and assessment criteria) and the social context (e.g. access to alternative peer solutions), but may not even require the exchange of feedback and thus encompass only minimal interactivity.

When researching the learning potential of formative peer assessment and designing instructional scaffolds to enhance it, it may be helpful to distinguish between learning processes at different levels of interactivity. I propose to differentiate the following three dimensions: learning from engaging with the core task and supporting materials (low interactivity), learning from providing and/or receiving peer feedback (medium interactivity), and learning from two-way, multi-turn dialogue with peers (high interactivity). In the following, I will elaborate further on these three dimensions.

4.1. Task dimension: Scaffolding students' learning from engaging with the core task

The exchange of peer feedback is a defining feature of formative peer assessment. However, some instructional scaffolds that are typical in formative peer assessment could also be implemented in individual learning settings, as they require only minimal interactivity. The examples that I will further discuss below are the provision of assessment criteria to learners, and the comparing and contrasting of alternative peer solutions. Both can be expected to support self-regulation and cognitive processing when learners engage with the core task.

As a first example, instructional scaffolds for formative peer assessment often involve the generation or dissemination of assessment criteria with regard to the core task (e.g., the writing assignment). Knowledge about criteria and standards for success is an important prerequisite for students' self-assessment and meta-cognitive regulation (Nicol & Macfarlane-Dick, 2006), and thus supports not only students' peer feedback skills, but also their engagement with the core task. Heightened awareness of performance standards might well contribute to the overall effectiveness of formative peer assessment (see, for example, Alqassab et al.; Leenknecht & Prins; and Rotsaert et al.). However, as it does not require the actual exchange of peer feedback, it might also be achieved through other instructional interventions, such as scaffolding students' self-assessment with prompts and checklists (e.g., Peters et al.). For example, studies that combined self- and peer-assessment using the same set of assessment criteria showed that self-

assessment may be as effective as (Meusen-Beekman, Joosten-ten Brinke, & Boshuizen, 2016) or even more effective than (Sadler & Good, 2006) peer assessment for fostering students' conceptual learning.

As a second example, formative peer assessment typically involves students' exposure to alternative task solutions from their peers. Even in the absence of any feedback exchange, comparing and contrasting alternative solutions to the core task can already be expected to facilitate learning (Alfieri, Nokes-Malach, & Schunn, 2013; Reinholz, 2016). In particular, comparing and contrasting alternative solutions by peers may lead learners to detect errors, gaps, or misconceptions in their own understanding of the target domain (e.g., the specific content domain on which a text has been written), or may lead them to adopt their peers' ideas and solution strategies (see, for example, the findings by Tsivitanidou et al.). Learners' processing of alternative peer solutions is likely influenced by their mental representation of their (real or imagined) peers. Thus, alternative peer solutions create a social context, and some minimal degree of interactivity. Nevertheless, comparing and contrasting alternative peer solutions may benefit learning even in the absence of any assessment task, and thus without the expectation to provide or receive peer feedback.

4.2. Feedback dimension: Scaffolding students' learning from providing and receiving peer feedback

The assessment task of providing feedback to a peer, and the learner's expectation and processing of received peer feedback, lie at the core of the formative peer assessment process. Many instructional scaffolds for fostering learning from formative peer assessment require only the exchange of products and feedback messages between learners (i.e., a medium level of interactivity), and do not necessitate a highly interactive, two-way multi-turn dialogue. These instructional scaffolds and the learning processes they target form the dimension of this framework. They are relevant during all phases of formative peer feedback.

Already during Task Performance, the expectation of later providing and receiving peer feedback may alter learners' goals and learning strategies. For example, if learners expect that a peer (rather than an "omniscient" instructor) will read and evaluate their product, they may include more explanations and justifications, which in turn foster learning (Topping, 1998; Reinholz, 2016). Moreover, as learners expect to later evaluate a product generated by a peer for the same or a very similar core task, this may already guide their attention in preparing their own product (Vollmer & Rheinberg, 2005). For example, they may imagine similarities and differences between their own and a peer's product, ponder how peers might tackle specific problems that they themselves are experiencing, or imagine alternative solution strategies that their peers might take. These processes might lead to a deeper reflection on solution strategies and ultimately to better performance and higher learning gains.

During Feedback Provision, learners ideally practice applying assessment criteria and explaining and justifying their reasoning to a peer. As several contributions to this special issue show, well-designed instructional scaffolds, for example in the form of training or scripts, scaffold learners in providing high-quality peer feedback (e.g., Alqassab et al.; Peters et al.). Scaffolded Feedback Provision, in turn, may also benefit students' performance on the core task (Van Popta Kral, Camp, Martens, & Simons, 2017).

During Feedback Reception and Revision, learners may form a mental representation of their peer assessor(s), which guides their processing of the received feedback. Ideally, the received peer feedback messages will remind learners of important goals and standards, and will make them aware of errors and gaps in their own product, alternative perspectives or solutions to their own product, and strategies for improving their own product (Hattie & Timperley, 2007). The effects of receiving formative peer feedback depend not only on the quality and content of the received feedback (Nelson & Schunn, 2009; Van der Pol et al., 2008), but also on the depth of processing of the feedback by the receiver (Berndt et al.; Wichmann et al.). This is moderated

by cognitive, social, and motivational factors, including the perceived expertise of the sender (Berndt et al.) or beliefs about peer feedback (Alqassab et al.). Instructional scaffolds therefore need to be tailored to the social structure (e.g. friendship, trust), learners' assessment skills, and their motivation in order to ensure the adequacy of received peer feedback as well as its mindful processing by the receiver.

4.3. Dialogue dimension: Scaffolding students' learning from discussing the core task, its assessment, and feedback with peers

In recent years, it has been argued that formative peer assessment can be enriched by engaging peers in dialogue beyond the mere exchange of products and feedback messages, creating opportunities for learning from mutual co-construction, tutoring, or argumentation and justification (Kollar & Fischer, 2010; Strijbos et al., 2009). The dialogues between peers when discussing core task, assessment, and / or feedback constitute the third and most interactive dimension of learning processes in formative peer assessment. Interactive dialogue, i.e. dialogue in which learners build upon one another's contributions and ideas (Chi & Wylie, 2014), can be promoted in each phase of formative peer assessment.

During Task Performance, the core task may already involve collaboration between learners, engaging them in the co-construction of ideas and joint problem-solving (as, for example, in intergroup or intragroup peer assessment; Strijbos et al., 2009). Further dialogic learning processes may take place if learners are engaged in formal or informal discussions around devising the criteria for assessing performance on the core task (see, for example, the contribution by Leenknecht & Prins). In the Feedback Provision phase, assessors can be confronted with specific feedback requests from the peer assessee (as, for example, in the study by Voet et al), and might also receive feedback on their provided peer feedback. In inter- and intra-group peer assessment, a group of peer assessors discuss their impression of the to-be-evaluated product and then agree upon a shared evaluation (cf. the contribution by Rotsaert et

al.). This opens up the possibility to engage in an interactive dialogue with other peer assessors, in which evaluations are justified, explained, and calibrated (cf. Reinholz, 2016).

During Feedback Reception, argumentative discussions with peers might contribute to a critical and reflected processing of received feedback (Kollar & Fischer, 2010). The range of possibilities is large, from a strictly scripted exchange of feedback requests, feedback messages, questions, answers, and/or explanations, to an open discussion of feedback among assessors and assessees (see, for example, the contribution by Rotsaert et al.). Peer feedback dialogues can further be anonymous (particularly if computer-mediated) or non-anonymous; and feedback provision can be mutual (in which case each learner assumes the roles of assessor and assessee in the same dialogue) or not (in which case the learner is the assessor in one dialogue and the assessee in another; cf. Topping, 1998). Another option to enhance interactive engagement is to enable learners to discuss received peer feedback with another peer who is not the assessor.

Finally, the Revision Phase also holds the potential to enable learning from engaging in dialogue with peers. For example, learners can work on their revision not individually, but collaboratively (e.g. Tsivitanidou et al.). If the initial product was created collaboratively, for instance, it makes sense to also revise it collaboratively. Furthermore, peer assessor and peer assessee can collaborate on revising a product, e.g. the assessor provides and justifies concrete suggestions for improvements, and the assessee explains and justifies whether, why, and how he/she took up these suggestions; similar to the peer-review process in academic publishing.

To summarize, all phases of formative peer assessment offer opportunities to engage learners in interactive discussions with their peers in which they can learn by argumentation, explanation, tutoring, joint problem-solving and / or mutual elaboration (Chi & Wylie, 2014). Exploring effective collaboration scripts and other instructional scaffolds that support interactive dialogue in formative peer assessment is thus a promising avenue for future research.

5. Conclusion

As the contributions to this special issue have demonstrated, formative peer assessment is an instructional method that offers many opportunities to foster students' learning, both with regard to the core task (e.g., academic writing) and with regard to their assessment and feedback skills. The contributions effectively addressed earlier calls (Kollar & Fischer, 2010; Strijbos & Sluijsmans, 2010) for more research into instructional scaffolds and the increased use of (quasi-)experimental designs in studying the factors that determine the effectiveness of formative peer feedback for student learning. However, open issues remain regarding effective procedures for establishing assessment criteria in formative peer assessment, regarding the benefit of formative peer assessment for transferable knowledge and skills, regarding the role of meta-cognitive and cognitive processes in the provision and reception of peer feedback by the learners, and regarding the proposed benefit of more interactive forms of formative peer assessment. Relevant learning processes in formative peer assessment can be described on three dimensions of increasing interactivity: in terms of the individual engagement with the core task (low interactivity), the provision and reception of peer feedback (medium interactivity), and argumentation and co-construction in dialogue with peers (high interactivity). Future research on promoting learning from formative peer assessment will benefit from exploring instructional scaffolds on all three dimensions of learning from formative peer feedback: learners engagement with the core task, the exchange of peer feedback, and discussions of the core task, its assessment, and feedback among peers.

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