Providing formative peer feedback: What do we know?

Ernesto Panadero ¹, Anders Jonsson ² & Maryam Alqassab ³

Author Note

¹ Departamento de Psicología Evolutiva y de la Educación. Facultad de Psicología. Universidad Autónoma de Madrid, Spain.
² Department of Science. Kristianstad University, Sweden.
³ Faculty of Psychology, Chair of Education and Educational Psychology, Ludwig-Maximilians-Universität, Munich, Germany.


Correspondence concerning this article should be addressed to: Ernesto Panadero. Despacho 109. Departamento de Psicología Evolutiva y de la Educación. Facultad de Psicología. Universidad Autónoma de Madrid, 28049, Cantoblanco. Spain. E-mail: ernesto.panadero@uam.es. Phone (+34) 914973553.

Acknowledgements: first author’s research funded by the Spanish Ministry of Economy and Competitiveness (Ministerio de Economía y Competitividad) under the Ramón y Cajal program (Reference number: RYC-2013-13469).
Providing Formative Peer Feedback: What do we Know?

Starting from the seminal work of Dewey, Piaget, Vygotsky, and Bruner (Falchikov, 2007), peers have been conceptualized as potential mediators in students’ learning and development. In recent decades, there has been an increasing interest in how students’ learning can be fostered through involving them in assessment via self- and peer assessment (Brown & Harris, 2013; Dochy, Segers, & Sluijsmans, 1999; Topping, 1998; Van Zundert, Sluijsmans, & Van Merriënboer, 2010). Both self- and peer assessment are now well-established fields of research with the following main lines of work: (a) the reliability/validity of self- and peer assessment scores (Falchikov & Boud, 1989; Falchikov & Goldfinch, 2000); and (b) the effects of such assessment on students’ learning, which have mostly been studied after the emergence of research on formative assessment (Black & Wiliam, 1998; Wiliam, 2011). Two more topics that have recently received more interest are: (c) the effects of self- and peer assessment on self-regulated learning and metacognition (Panadero, Jonsson, & Botella, 2017; Panadero, Jonsson, & Strijbos, 2016) and (d) the role of psychological and social factors in self- and peer assessment (Panadero, 2016; van Gennip, Segers, & Tillema, 2009; Yan & Brown, 2016).

Consequently, researchers have become interested in the type of information that students exchange in peer assessment situations, with research focused on whether the quality of such information can lead to improved learning compared to just providing a score (i.e., peer scoring). This information is known as peer feedback. There has been an increased interest in peer feedback – a trend reflected in the publication of dissertations that focus on various aspects of peer feedback (Alqassab, 2016; Gan, 2011; Gielen, 2016; Gielen, 2007; Rotsaert, 2017). The aim of this chapter is to explore the
concept of peer feedback, presenting the results of the main dissertations and discussing the key empirical themes that have been investigated.

**Introduction to the Peer Feedback Concept**

Simply put, peer feedback is feedback that comes from a peer. Nevertheless, “peer” and “feedback” need further clarification as both are multifaceted constructs. A peer is an equal in one or more of the following aspects: age, educational level, or level of expertise. Feedback in an educational context refers to any information provided to students about their performance. This information may take different forms ranging from a single grade/score to very detailed qualitative information (e.g., explaining in detail how to improve an essay). There are tensions regarding the summative and formative purposes of feedback, and peer feedback is not excluded from this controversy (see next section, also Brookhart, Chapter XX, this volume). For the purposes of this chapter, we will adhere to the definition of formative feedback offered by Shute (2008): “information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of improving learning” (p. 154). This definition includes the original idea that feedback is information routed back to an original source of action, in our case the student. It also situates the formative use of feedback within a learning context: it aims to improve students’ learning. Furthermore, this definition allows feedback to take different forms when provided in different learning contexts (Lipnevich, Berg, & Smith, 2016), and covers differently types of feedback that can be directed to the task, process, self-regulation, or personal levels (Hattie & Timperley, 2007). What students do with that information and their reactions to it will depend on some features of feedback, but also on personal variables (Jonsso & Panadero, this volume; Lipnevich et al., 2016). In other words, students’ decision to act or not act upon the received feedback in order to close the gap between their actual
performance and the desired one goes beyond our conceptualization of what constitutes feedback.

**Disentangling Uses of Peers: Assessment and Learning**

The tensions mentioned above between feedback for summative and formative purposes have also been translated into research around students’ involvement in evaluating a peer’s piece of work (Liu & Carless, 2006). As proposed by Gielen et al. (2011, Figure 1), peer assessment can serve five purposes: social control tool, assessment tool, learning tool, learning-how-to assess tool, and active participation tool. This diversity of purposes has led to inconsistencies in the terminology. For instance, research focusing on peer feedback may be labeled as peer assessment (e.g. Sluijsmans, Brand-Gruwel, & van Merriënboer, 2002) and, vice versa, research on peer scoring and assessment may be labeled as peer feedback (e.g. Cho, Chung, King, & Schunn, 2008). Some studies have used a combination of these terms to differentiate between different purposes (e.g., Rotsaert, Panadero, Schellens, & Raes, 2017a). This confusion can be explained by the fact that the two main areas of research into peer involvement in assessment have either revolved around accuracy-validity/reliability of scoring (Falchikov & Goldfinch, 2000; Panadero, Romero, & Strijbos, 2013), or effects of students’ involvement with assessment on students’ learning (Dochy et al., 1999; van Zundert et al., 2010). Due to the interchangeability in the use of the terms *peer assessment* and *peer feedback*, it can be difficult to separate different purposes of using peer feedback in the literature.

It is therefore important to start using a more precise terminology. We are not the first issuing such a call (Liu & Carless, 2006; McCarthy, 2016). In this chapter, we will operationalize peer feedback and *formative* peer assessment as referring to the provision of qualitative information about student performance (e.g., strengths and
weaknesses), but without a peer awarded score or grade. Peer assessment, on the other hand, will refer to situations, in which the assessor provides qualitative feedback and a score or grade (Liu & Carless, 2006). We also propose a third category, referring to situations, in which a score is given without being accompanied by any type of qualitative feedback. In the latter case the term peer scoring will be used, similar to what has been done in the field of self-assessment (for a review, see Panadero, Brown, & Strijbos, 2016).

These distinctions are important in order to promote a more unified use of terms in the field, but also because students are likely to approach the task differently depending on whether they are asked to score or grade a peer’s piece of work or not, which affects their social interactions (for a review see Panadero, 2016). Similarly, students could be expected to react to the feedback provided by peers differently compared to the one coming from a teacher (Gielen, Dochy, Onghena, et al., 2011).

Peer assessment and peer feedback can be seen as forms of either formative assessment (Topping, 1998) or collaborative learning (van Gennip, Segers, & Tillema, 2010). However, depending on the purpose, the actual implementation would differ. In collaborative learning activities, students provide peer feedback to each other in order to achieve a shared learning goal. This situation is not the same as providing qualitative feedback to a peer working on his or her own individual task. Even if peer feedback is an integral part of collaborative learning situations, it is still a different feedback situation than providing peer feedback from an “assessor position”. The collaborative learning feedback situation represents a more “natural” (or neutral) interaction, which is more balanced in terms of roles and processes through which feedback is delivered. One example of these different voices and roles can be found in the study by Gan and Hill (2014). In this study, the characteristics of verbal peer feedback were explored during a
collaborative task using a scheme that included two dimensions of interactive/non-
interactive and dialogic/authoritative. This study will be presented in greater detail
below.

The main message from this section is that the purpose of the activity and the
type of feedback expected from students make a difference in how students approach
the activity. Furthermore, the instructions that they receive on how feedback should be
formulated and delivered are crucial for what students actually provide to their peers.
Therefore, the act of providing feedback to a peer will be different if students are asked
to score, to provide qualitative feedback, or to collaborate with their team. All of these
possibilities need to be considered when investigating the effect of peer feedback on
learning.

**Conditions Influencing the Effectiveness of Peer Feedback**

A significant number of reviews and meta-analyses conducted on the most
effective characteristics of teachers’ feedback for student learning and performance
(e.g., Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2008) revealed that the
effect of feedback is shaped by (a) characteristics of the feedback, (b) characteristics of
instruction, and (c) characteristics of students. The interaction among these three factors
determines students’ reactions to the feedback received and whether or not they will
engage with it (Jonsson & Panadero, this volume). The same factors are equally relevant
for peer feedback. Nevertheless, there are some aspects that are more likely to influence
peer feedback that are not always included in teacher feedback models. These are
interpersonal variables, which we describe in the forthcoming section.

**Peer Feedback Characteristics**

Drawing upon the literature on teachers’ feedback, the characteristics of peer
feedback include such categories as content, function, and presentation (see Narciss &
According to Narciss and Huth (2004), examples of content aspects are level of performance, accuracy, focus, level of detail, and comprehensibility. Regarding aspects of function, two different models have been proposed. Narciss and Huth (2004) suggested that the characteristics of function are cognitive, metacognitive, and motivational aspects of feedback. Hattie and Timperley (2007) suggested the following aspects (or levels): (a) the task, (b) the processes that produce successful performance on the task, (c) self-regulation, and (d) the self. Finally, regarding feedback presentation, the following aspects have been discussed: frequency, timeliness, elaborated feedback in manageable units, and tone (e.g., Narciss & Huth, 2004; Shute, 2008).

**Characteristics of Instruction**

Narciss and Huth (2004) proposed several factors related to the instructional context that can contribute to the effects of feedback on learning. These include learning goals, characteristics of the learning task, and possible sources of learning difficulties or problems. When it comes to peer feedback, these factors are important as they can hinder or facilitate the success of peer feedback activities. For instance, the complexity of the learning task can influence the accuracy of peer assessment (see van Zundert, Sluijsmans, et al., 2012). Additionally, the amount of instructional support that students receive during peer feedback activities (e.g., scaffolds, rubrics, training), as well as the purpose of peer feedback activities (e.g., to teach domain knowledge or to teach assessment skills) can be regarded as important aspects of the learning context.

**Individual Characteristics**

Narciss and Huth (2004) proposed that the students’ individual characteristics that can influence the effect of feedback are students’ cognitive factors (e.g., prior knowledge), metacognitive factors, and motivational factors (e.g., beliefs, academic
self-efficacy). Due to the reciprocal nature of peer feedback, we stress that individual characteristics of the recipient and the provider are equally important for peer feedback and can influence the provision as well as the reception of peer feedback (see Strijbos & Müller, 2014).

**Social and Interpersonal Variables**

Several researchers stressed the role of social factors in peer assessment and peer feedback activities and acknowledged the importance of these aspects beyond controlling for peer assessment validity or reliability (Panadero, 2016; Strijbos, Ochoa, Sluijsmans, Segers, & Tillema, 2009; Strijbos & Sluijsmans, 2010; van Gennip et al., 2009). These are variables that determine interpersonal communication among peers that can also influence processes and outcomes of peer assessment or peer feedback. In a recent review, Panadero (2016) identified 10 research themes that appear in the peer assessment literature, grouped into three categories: intra-individual, inter-personal, and cognitive aspects. Among those 10 themes are friendship marking (e.g. Panadero et al., 2013), psychological safety (e.g., van Gennip et al., 2010), trust in the other as an assessor (e.g. Lin, Liu & Yuan, 2002), and trust in the self as an assessor (Sluijsmans et al., 2002). The main conclusion of the Panadero’s (2016) review was that formative approaches seemed to help alleviate some of the interpersonal tensions that can occur during peer assessment.

In sum, although a number of factors mentioned in this section are frequently found in the teacher’s feedback literature, they can also affect peers as a source of feedback. Some of them are even more important for peer feedback because of its egalitarian nature. Next, we will explore the main lines of research on peer feedback.

**Empirical Evidence on Peer Feedback**
Research with a focus on peer feedback characteristics is relatively recent. Searching for peer feedback in databases reveals that the vast majority of studies have been published from 2005 and onwards. A significant percentage of these publications are based on students’ perceptions of peer feedback implementation (e.g., Chesney & Marcangelo, 2010; Gikandi & Morrow, 2016). They consist of studies seeking students’ or teachers’ opinions about the implementation of peer feedback, many times without a more objective dependent variable (e.g., performance). This research can be problematic, as some studies do not acknowledge the limitations of such methodology.

Despite certain methodological concerns, the main focus of this chapter is on specific characteristics of peer feedback that lead to more learning. We present five dissertations that examined peer feedback in the realm of formative peer assessment. The goal behind the presentation of these dissertations is to explore in details the rich type of empirical evidence that represents a coherent line of work. Further, after discussing dissertations, we identify seven major themes in the peer feedback literature.

**Five Dissertations on the Topic of Peer Feedback**

**a) Sarah Gielen (2007): Peer Assessment as a Tool for Learning**

This dissertation was published in 2007, defended at the University of Leuven (Belgium) and completed under the supervision of Filip Dochy and Patrick Onghena. The work of Dochy in the 1990s onward was seminal in the formative assessment field, and Gielen’s dissertation is an example of his influence. The six publications in this dissertation made both theoretical and empirical contributions. The three theoretical publications were crucial in exploring the formative use of peer assessment. In the first publication, Gielen, Dochy, and Dierick (2003) examined the role of peer assessment in the larger assessment system of a learning environment, and discussed its impact on the learning processes of students. Peer assessment is shown to enhance the consequential
validity (what happens as a consequence of a particular assessment, see Messick, 1998) of the larger assessment system. By introducing peer assessment, the contribution of an assessment system to a powerful learning environment can be strengthened.

The second publication (Gielen, Dochy, Onghena et al., 2011) has already been cited above, and it explored the different goals that peer assessment may have. Identifying these goals is important to accurately evaluate the success of a peer assessment implementation. The study identified five types of goals: assessment tool, learning, social control, preparation of self-monitoring and self-regulation, and students’ active participation. Additionally, the researchers found that most of the research had been conducted with peer assessment as an assessment tool but its use as a means to increase students’ learning was increasing, mostly as a result of the emergence of research on formative assessment. Finally, in her third theoretical contribution, Gielen developed a tool to analyze features of peer assessment, thereby providing a framework to capture and categorize the diversity of peer assessment in education (Gielen, Dochy, & Onghena, 2011). Her inventory expanded the one by Topping (1998) and includes 20 categories organized around five clusters (see Gielen et al., 2011).

Regarding Gielen’s empirical contributions, three publications explored the following themes: 1) is peer feedback as effective as teacher (expert) feedback? 2) what are the strengths and weaknesses of both peer feedback and teacher feedback? 3) how to design an effective (peer) feedback system? and 4) what constitutes an effective peer feedback and who benefits from it? These themes are explored, alone and in combination, in the different dissertation studies. The first theme is addressed in two studies – one in secondary education and the other in higher education. The study conducted in the seventh grade writing class (Gielen, Tops, Dochy, Onghena, & Smeets, 2010) showed that there were no significant differences between teacher and peer
feedback in terms of students’ progress. Another publication from Gielen’s dissertation (Gielen et al, 2007) further explored this area by studying first year university students’ perceptions about (collective) staff vs (individualized) peer feedback. This was done not only in terms of effects (theme 1), but also in terms of feedback characteristics (theme 2). Because this study examined an assessment system in which both themes were combined, it also addressed the design question (theme 3). The authors reached the following conclusions: (a) half of the participants were willing to trade in the credibility of staff feedback for the specificity of peer feedback, (b) peer and staff feedback were shown to be complementary, and they each provided the conditions under which the complementary source became better. By involving peers in providing specific individualized feedback, educators focused on more general aspects of their feedback, such as misconceptions. Most importantly, according to students, both types of feedback were needed. Furthermore, because peers took care of the individual feedback, staff could save time (by providing their feedback only collectively), which, in turn, was invested in facilitating a good peer feedback system that provided useful individualized feedback. This investment resulted in opportunities for personal coaching among students and lively discussions leading to deep and cooperative learning and metacognitive growth as measured via self-report.

The study in the secondary education context that was discussed earlier addresses the third theme. Gielen, Tops, et al. (2010) examined the additional value of peer feedback using an intervention study. More specifically, they looked at the effects of adding a priori and a posteriori questions aimed at supporting the asessee’s response to peer feedback. Their findings showed that the extended peer feedback system (i.e., in which students were encouraged to react to the feedback they had received) was superior to both the “simple” peer feedback condition and the teacher feedback
condition, in terms of students’ progress in writing. However, in another empirical study, conducted in a seventh grade writing class (Gielen, Peeters, Dochy, Onghena, & Struyven, 2010) that focused only on these different configurations of peer assessment, the superiority of an extended peer feedback system (i.e., including interventions to enhance the asseesee’s reflection after receiving the feedback), could not be replicated.

Finally, the latter study also investigated peer feedback at the micro-level (theme 4). Gielen et al. (2010) examined differences in the quality of feedback provided by different peer assessors and its effects on the learning gains of both assessors and asseesees after the peer feedback phase. Although the quality (in terms of constructiveness) of feedback in this study was low overall, receiving “better” feedback was associated with higher performance gains, while providing better feedback was not.

Why is this contribution important? This dissertation provided a strong theoretical exploration of the use of peer assessment for formative purposes that was later followed by two other important dissertations focusing on similar topics (Van Gennip, 2012; Van Zundert, 2012). Further, Gielen’s work identified different peer assessment purposes and examined differences and similarities in peer and expert/teacher feedback and its effects on student learning and other meaningful outcomes (e.g. Cho, Schunn, & Charney, 2006).

b) Mark Gan (2011): The Effects of Prompts and Explicit Coaching on Peer Feedback Quality

This dissertation was published in 2011, defended at the University of Auckland (New Zealand) and was conducted under the supervision of John Hattie and Mary Hill. Hattie’s research focuses on the effects of feedback on students’ achievement, whereas Hill’s main areas of research are educational assessment and teacher professional learning.
Gan’s dissertation explored characteristics of peer feedback and instructional scaffolding effects on the peer feedback quality. Parts of the theoretical framework were already published in Hattie and Gan (2011), which provides an overview of perspectives of learning and the nature of feedback, including the following psychological and educational theories: objectivism, information processing, socioculturalism, and visible learning and teaching. Additionally, they further developed the three questions proposed by Hattie & Timperley (2007) (i.e., where am I going, how am I doing, where to next). While there is some information about peer feedback at the end of the chapter, the main focus of this publication was on the review of instructional feedback.

The empirical part of Gan’s dissertation is composed of three studies. The first study (Gan & Hill, 2014) used a descriptive methodology to explore what types of verbal peer feedback students use in a chemistry task. Gan and Hill analyzed feedback along two dimensions: dialogic/authoritative and interactive/non-interactive and found that the participants predominantly used an “interactive/authoritative communicative approach, with peer feedback as confirmation or evaluation. Furthermore, the participants are also capable of a more interactive/dialogic exchange, characterised by elaborative peer feedback” (p. 727).

The second study (Gan & Hattie, 2014) explored the use of a scaffolding framework provided to the feedback givers in the form of question prompts on how to provide feedback. They found that this intervention increased the number of comments related to knowledge of errors, suggestions for improvement, and process level feedback (as defined by Hattie and Timperley, 2007). A key finding was that “prompting peer feedback in the use of criteria, feedback specificity, and feedback levels” increased the quality of feedback. The third study (unpublished) built on the two previous studies to increase the features of the intervention (e.g., graphic organizer with
feedback levels) received by the feedback givers. Findings were aligned with the second study: Scaffolding tools enhanced the quality of the peer feedback produced.

*Why is this contribution important?* This dissertation explored the nature of peer feedback content and used scaffolding elements to improve the quality of the feedback following Gielen et al. (2010) work. In particular, Gan’s studies built on the model of Hattie and Timperley (2007) to devise a peer feedback framework to allow students to engage in productive discursive interactions within a collaborative and visible learning context.

**c) Mario Gielen (2016): The Impact of Structuring Peer Feedback in Computer Supportive Collaborative Learning Environments**

This dissertation was published in 2016, defended at the Ghent University (Belgium), and conducted under the supervision of Bram De Wever who is a specialist in computer supportive collaborative learning, technology enhanced learning, and the role of scripting in promoting better collaboration.

Gielen’s dissertation focuses on exploring how peer assessment practices can be enhanced to improve students’ learning by structuring the peer feedback process for both assessors and assessees. This dissertation contains five empirical studies extracted from three different interventions. The first intervention and empirical study (Gielen & De Wever, 2012) explored the effects of structured peer feedback on student performance. The study found no significant effects. There was, however, a significant effect of practice: both the experimental and the control group created better wiki products from pre- to post- tests. Additionally, participants in the structured peer feedback condition were more critical as providers and receivers of feedback and perceived the received feedback as more valuable, compared to their counterparts in the control group.
In the second intervention, the focus was on intervening in the assessor (feedback provider) alone, with the first study exploring the impact on peer feedback quality and performance, and the second study exploring the effects on more specific feedback characteristics (e.g., elaboration, verification, etc.). In their investigation Gielen and De Wever (2015a) explored the effects on feedback quality and student performance of two levels of intervention: elaborate structure peer feedback versus basic structure, against a control condition. For both experimental conditions, a significant effect was found for feedback quality and performance, compared to the control condition. Additionally, after several rounds of practice, peer feedback quality was higher in the elaborate condition as compared to the control, and both experimental conditions surpassed the control on performance. The second published study from this intervention (Gielen & De Wever, 2015b) reported a detailed analysis of the peer feedback content based on the different levels of structuring. They found that all conditions provided a balanced proportion of verifications and elaborations, but also that the assessors receiving a peer feedback scaffold produced more general elaborations focusing on specific criteria and negative verifications. The authors emphasized the importance of such “negative” feedback as it might generate an increased effort in those who are on the receiving side of feedback.

Finally, in the third intervention, both the assessor and assessee underwent interventions to increase the quality of the feedback provided and the level of detail of the feedback requested. Additionally, the two studies from this intervention had a similar structure as the ones in the second intervention: the first one explored the effects of experimental manipulation on performance and peer feedback quality whereas the second explored in detail specific characteristics of the peer feedback given. In the first published empirical study (Gielen & De Wever, 2015c), participants were assigned to
one of four experimental conditions with scaffolds of varying degree of elaboration. The quality of the peer feedback and performance increased in all four conditions over time, possibly due to a practice effect. Additionally, when the assessee was scaffolded to request specific peer feedback from the assessor, this had a positive effect on peer feedback scores. In the second study (Gielen, 2016) the researchers found that all conditions showed a balanced proportion of “mostly positive verifications and equally informative and suggestive elaborations” (p. 135). No significant differences were found among conditions.

Why is this contribution important? This contribution explored differential effects of feedback scaffolds for both assessors and assesses. Additionally, it explored these effects on three main outcome variables: performance, feedback quality, and feedback content categories. Finally, it continued the exploration of peer feedback content creating a sophisticated coding scheme.

d) Maryam Alqassab (2016): Peer feedback provision and Mathematical Proofs: Role of Domain Knowledge, Beliefs, Perceptions, Epistemic Emotions, and Peer Feedback Content

This dissertation was published in 2016, defended at the Ludwig-Maximilians University (Munich, Germany) and conducted under the supervision of Jan-Willem Strijbos, a specialist in peer assessment, peer feedback, collaborative learning and Computer Supported Collaborative Learning (CSCL), and Stefan Ufer, a specialist in mathematics education. Additionally, John Hattie was an international advisor.

Alqassab’s dissertation consists of two empirical studies that focus on the individual characteristics that might influence peer feedback provision such as domain knowledge, beliefs about peer feedback provision, peer feedback providers’ perceptions
of peer feedback, and epistemic emotions. The sample comprised preservice mathematics teachers who participated in two studies.

In the first study, all participants received a structured peer feedback training based on Hattie and Timperley’s (2007) model with four levels of feedback. Before the training, the participants were grouped into low, medium, and high domain knowledge groups based on their knowledge in geometry. The participants’ peer feedback skills and beliefs were measured pre and post using a coding scheme based on Hattie and Timperley’s (2007) model. The study revealed that the training was beneficial for peer feedback provision skills, but that their domain knowledge moderated the effect. Groups with medium and high levels of domain knowledge produced more self-regulation level feedback, whereas the participants with lower levels of domain knowledge produced more task-level feedback. For the other two categories (process and self) no significant differences were found. Alqassab (2016) also found that the participants’ beliefs about peer feedback became more realistic as these beliefs were less positive after the intervention, regardless of participants’ domain knowledge.

Regarding the second study, the participants provided peer feedback in two conditions: one with a near-correct mathematical problem and the other with an incorrect solution to the same problem. There were five dependent variables. The first variable was participants’ eye movements that were tracked and analyzed based on the “proportional total dwell time” (PTDT) (i.e., time the participant spent looking at the figure or text, also called fixation time). The second variable measured how well the participants understood the proof, called “proof comprehension”\(^1\). The third variable

---

\(^1\)Proof comprehension means the understanding of a proof. In mathematics education there are several frameworks that describe the assessment of the understanding of different components of a proof. It is typical in mathematics education to measure students’ proof comprehension (understanding of an already performed proof). This was used as a learning outcome.
was the feedback content provided to the fictional peers. The quality of this feedback was analyzed based on type (cognitive surface, cognitive verification, cognitive elaboration, self-efficacy, and affective function) and accuracy. The fourth variable was three emotions as experienced by the participants: curiosity, confusion, and anxiety. Finally, the fifth variable was beliefs about peer feedback and the participants’ perceptions about the quality of peer feedback.

First, regarding PTDT, Alqassab (2016) reported that error in the peer solution led to reliance on a text-based (analytical) approach, whereas the absence of errors facilitated reliance on figure (i.e., a figure-based mental model). Second, regarding proof comprehension, those participants who provided peer feedback on the near-correct peer solution had a better understanding of the mathematical proof as compared to those who provided peer feedback on the incorrect peer solution, after controlling for their domain knowledge. The researcher suggested that errors in the peer solution hindered students’ understanding of the proof during peer feedback provision. Third, the study revealed that the feedback content was not affected in the type category since participants in both conditions provided similar types of feedback. However, there was a significant difference in terms of accuracy with preservice teachers in the near-correct solution condition providing more accurate feedback. Fourth, regarding the experienced emotions, participants in the erroneous condition experienced more curiosity, but there were no differences in confusion. Additionally, the correlation between emotions and feedback accuracy was explored revealing that confusion and anxiety were negatively related to accuracy in the near-correct condition. Fifth, regarding the peer feedback perceptions, the study found that the participants’ perceptions about the quality of their

---

2 Accuracy was determined in terms of the identification of errors and correct statements regarding the peer solution. The authors developed a coding scheme that contained whether each part of the peer solution was correct or incorrect. And if the student got any of that correctly they awarded them one point for that.
feedback was positively correlated with their confidence in providing peer feedback. Finally, the researcher concluded that the participants’ confidence regarding the feedback they provided, their perceptions of their peer feedback\(^3\), confusion and anxiety were possible indicators of accuracy.

**Why is this contribution important?** This dissertation made a number of significant contributions. First, it explored the role of the feedback provider in terms of a number of variables (e.g., emotions and perceptions). Second, it explored the effect of domain knowledge on peer feedback provision. Although this effect had previously been studied, it was investigated from a different angle (Sluijsmans et al., 2002) and only in the domain of writing (Patchan, Hawk, Stevens, & Schunn, 2013; Patchan & Schunn, 2015). Thirdly, this dissertation was a pioneer study on the use of eye tracking and exploring the role of emotions in peer feedback. Finally, it explored the effects of peer feedback on learning outcomes (i.e., proof comprehension), an aspect overlooked in previous research.

e) Tijs Rotsaert (2017): The Social Nature of Peer Assessment in Secondary and Higher Education

This dissertation was published in 2017, defended at Ghent University (Belgium) and was conducted under the supervision of Tammy Schellens, a specialist in educational technology and teaching methods. Additionally, the first author of this chapter was also involved as an international collaborator.

Rotsaert’s dissertation addressed three main topics: the social and interpersonal nature of peer assessment, the quality of peer feedback, and the organization and management of peer assessment practices with a special focus on the role of anonymity.

---

\(^3\) *Confidence regarding feedback provided* is more trait-like similar to what other researchers have called *trust in the self as an assessor; perceptions of their peer feedback* is specific to the very peer feedback that the participants provided in this activity.
The dissertation contains five empirical studies. The first three mostly related to peer assessment and will be presented only briefly. The last two explored peer feedback.

The first study (Rotsaert, Panadero, Estrada, & Schellens, 2017b) was conducted via a survey distributed to 3,680 Flemish secondary students and explored their perceptions of peer assessment interpersonal variables (e.g., trust) and their beliefs on the educational value of peer assessment. The results revealed that the educational value could be predicted by trust in the self and the other, awareness of negative interpersonal processes that might affect peer assessment (e.g., fear of disapproval and friendship marking), and beliefs about peer assessment accuracy. Additionally, the importance that students attributed to anonymity was found to be a negative predictor of peer assessment conceptions. The second study (Rotsaert, Schellens, & Panadero, 2017c) explored the effects of 225 teacher conceptions of peer assessment and students’ interpersonal processes on the educational value of peer assessment. The researchers found that teachers were moderately aware of students’ concerns about the influence of interpersonal processes on peer assessment and the importance that students attributed to anonymity. No significant relation was found between the educational value of peer feedback as perceived by the teachers and interpersonal variables or anonymity. The third study explored the effect of a technological tool (Mobile Response Technology) to provide anonymity for the assessors in a face-to-face peer assessment activity. Apart from a number of relationships among different peer assessment conceptions and interpersonal variables, the researchers found that students preferred non-anonymous teacher feedback and assessment.

The fourth study (Rotsaert et al, 2017a) investigated the effects of (a) practice (10 occasions) and (b) a scaffolding tool to filter out relevant information for feedback receivers on three dependent variables. The participants worked in groups, both
providing and receiving peer feedback. The first dependent variable, peer feedback quality, was gauged by analyzing the feedback content considering different characteristics as verifications and elaborations. Results showed that only the practice effect was significant for the improvement of the quality of the feedback through an increase of negative verifications (“a dichotomous judgment to indicate that a response is right or wrong”), and informative and suggestive elaborations (“relevant information to help the learner in error correction” Hattie and Gan, 2011, p. 253). The second variable, perceived peer feedback skills, also improved with practice. Finally, the third variable, perceived usefulness of the received feedback, was rated highly by all participants at all measurement occasions.

The fifth study (Rotsaert et al, 2017c) explored the role of anonymity in peer feedback quality and students’ perceptions. The 46 undergraduate participants organized in working groups went through four cycles of peer assessment with the initial two cycles being anonymous and the last two not. The results showed that peer feedback quality increased based on the practice effects and that moving into the non-anonymous cycle continued this increase. Additionally, the change in the anonymity status did not negatively affect the perceptions of peer feedback skills, which increased as a result of practice, nor did it affect the conceptions of peer assessment. Furthermore, although students did find anonymity to be an important factor within peer assessment, they strongly acknowledged the value of a rich and interactive, non-anonymous feedback environment.

*Why is this contribution important?* This dissertation discusses practice and anonymity as moderators of the quality of peer feedback. The results show that practice is a crucial factor to increase the quality of the feedback students give to each other. Additionally, it has a more refined version of Gielen’s feedback content categories that
could be used in future research. Furthermore, this dissertation adds to the peer assessment literature by exploring the role of interpersonal variables (for a review see Panadero, 2016) in both teachers and students, as well as the effects of feedback anonymity on students’ perceptions of feedback and quality of their performance.

Features of Peer Feedback that Contribute to Students’ Learning

From the dissertations summarized above and the existing peer feedback literature, we have identified seven central themes of research related to four main aspects influencing the effectiveness of peer feedback. In this section, we will present these themes, then discuss the effect of peer feedback on achievement. The themes are presented under headings that describe the general area of research, and are numbered one through seven.

Peer Feedback Characteristics

Regarding the characteristics of peer feedback, we have identified two themes of research, namely differences between peer and teacher feedback, and the nature and quality of peer feedback content.

1. Differentiation between peer and teacher feedback. This line of work explores the pros and cons of peer feedback as compared to feedback from teachers as experts. Multiple publications by Cho and colleagues (Cho et al., 2008; Cho & MacArthur, 2010; Cho, Schunn, & Charney, 2006) extend the earlier work by Paulus (1999). Among the above-mentioned dissertations, research on the differentiation between peer and teacher feedback was taken up by Gielen, both empirically (Gielen, Dochy, et al., 2007; Gielen, Tops et al., 2010), and theoretically (Gielen, Peeters, et al., 2010). One of the most salient differences between teacher and peer feedback is that teachers are supposed to be experts in the domain. However, Gielen’s research found that
Formative peer feedback

peer feedback has distinct features that can also be beneficial for the recipients of peer feedback. Previous research has shown that, when they do not know the source of the feedback, students considered peer feedback as useful as teacher feedback (Cho et al., 2006). The work by Cho and colleagues has also shown that peer feedback can be as productive as feedback from the teacher, because: (a) peers struggle with the same learning objectives and difficulties and can sometimes aid in addressing them better than an expert, (b) peers might share the same “language”, and (c) peer feedback may contain more non-directive comments, which may lead to more complex revisions and higher quality performance (Cho, Cho, & Hacker, 2010).

2. Nature and quality of peer feedback content. A strong line of research explored the types of feedback students produce when asked to provide peer feedback. All of the aforementioned dissertations have studied the content of peer feedback either in a descriptive way (e.g., Gan, 2011 found that students used predominantly an interactive/authoritative communicative approach), or as a dependent variable (e.g., Gielen, 2016 explored the effects of scaffolding peer feedback on the content of the feedback). Regarding Alqassab’s (2016) dissertation, both empirical studies used peer feedback content as a dependent variable. In the first study, the groups with medium and high domain knowledge showed differential effects providing more self-regulation level feedback, and the students in the low domain knowledge group provided more task feedback. In the second study, there was no effect of the experimental conditions. Lastly, Rotsaert (2017) also used peer feedback content as a dependent variable in the fourth and fifth studies. These studies
showed that the peer feedback content quality increased due to the practice effect, but the intervention did not have an effect in the first investigation (Rotsaert et al., 2017c). Additionally, the change in the anonymity status did not affect the quality of the peer feedback (Rotsaert et al., 2017c).

Additionally, Strijbos, Narciss and Dünnebier (2010) used experimental design to show that the participants were able to differentiate between peer feedback of different quality. This study showed that students are capable of identifying the quality of feedback as received by a peer. In conclusion, research shows us that: (a) the quality of peer feedback can be increased via interventions, (b) students are well aware of, and are able to identify, peer feedback of different quality, and (c) peer feedback, although having different characteristics as compared to teacher feedback (e.g., research by Cho and colleagues) can be of high quality but other factors such as domain knowledge can influence that.

**Instructional Characteristics**

Research related to instructional characteristics is mainly concerned with the amount or type of instructional support that the students receive during the peer feedback activity, such as scaffolding as well as practice effect and training.

3. **Scaffolding peer feedback.** This line of work concerns providing different scaffolds either to help feedback providers to produce better quality feedback or to help feedback receivers to ask for feedback or assimilate it better. This research has connections with studies in collaborative learning settings in which students are scaffolded for better interactions (Ge & Land, 2003). Examples of this type of research can be found in the aforementioned dissertations. Gan (2011) explored the effects of question prompts and
graphic organizers provided to the persons delivering feedback. Such scaffolding increased the quality of peer feedback (Gan & Hattie, 2014; Gan, 2011). The main aim of Gielen’s dissertation was to explore how providing scaffolding to both providers and receivers of feedback would increase peer feedback quality and performance. The scaffold was based on “scripting”, that showed significant effects on peer feedback and on performance in one of the three studies exploring this (Gielen & De Wever, 2015a). In the other two studies, only the effect of practice was significant (Gielen & De Wever, 2012, 2015c). Finally, Rotsaert et al. (2017a) found that the effects of a tool for filtering out information that intended to help asseesees identify the most important information in the peer feedback quality were not statistically significant. Instead, only the practice effect made a significant difference. As one can see, the use of scaffolds seems to have mixed results, with the researchers suggesting different reasons for non-significant results, such as lack of time or practice effect for all conditions neutralizing the effects of the intervention. Nevertheless, the use of scaffolds to help provide better peer feedback should, when the implementation conditions are optimal, enhance peer feedback quality and, thus, students’ performance.

4. Practice effect and training. Regarding practice, five studies analyzed from the dissertations found significant effect of practice on the quality of peer feedback (Gielen & De Wever, 2012, 2015a, 2015c; Rotsaert et al., 2017a, 2017c), and on perceived peer feedback skills (Rotsaert et al., 2017c et al., submitted). All these results show that it is important to consider previous experience and practice on improving the quality of peer feedback. Additionally, Panadero and Brown (2017) found that one of the main
predictors of teachers’ implementation of peer assessment is previous peer assessment experience. This would indicate that for peer assessment or peer feedback to be a successful instructional activity, it is important to consider the influence of practice. Therefore, we would like to suggest that, as proposed by Panadero et al. (2016) in relation to self-assessment, a developmental approach to the training of peer feedback is needed. In other words, students need practice to actually master the skill necessary for providing and interpreting peer feedback.

Another aspect that is closely related to the practice effect is training. Gan (2011) showed that training students resulted in improvement in their peer feedback content compared to a control group – an effect that was also previously found with preservice teachers (see Sluijsmans et al., 2002; Sluijsmans et al., 2004). Accordingly, it seems that the degree to which students receive instructional support (scaffolding, training, and opportunities to practice) can facilitate the development of better peer feedback delivery skills.

**Individual Characteristics**

Despite the importance of students’ individual characteristics, we have only identified two main research topics: domain knowledge, and students’ emotions, beliefs, and perceptions.

5. **Domain knowledge.** Whereas practice refers to individuals’ expertise pertaining to the process of peer feedback, domain knowledge is expertise pertaining to the task at hand. Regarding domain knowledge, the work by Alqassab (2016, first study) showed that students with different levels of domain knowledge (high, medium, and low) provided different types of peer feedback, a result supporting previous research (Patchan et al., 2013; Patchan
& Schunn, 2015). Panadero et al. (2016) questioned why the self-assessment field has not considered domain knowledge as a key variable determining the effectiveness of self-assessment. Due to some of the similarities between self-assessment and peer assessment, it could be assumed that a similar call should be made here to explore this crucial variable for the quality of peer feedback in more detail. In addition, the work by Strijbos et al. (2010) also considered the role of domain knowledge by investigating how concise general or elaborated specific peer feedback provided from high or low competence peer influenced recipients’ perceptions of peer feedback and their performance.

6. **Beliefs, perceptions, and emotions.** These variables are likely to influence the processes and outcomes of peer assessment and peer feedback, yet their role is still widely ignored. Due to the limited empirical evidence and the fact that available studies tend to explore these constructs together, we also clustered them in one theme. Once the corpus of knowledge increases they should be presented separately. In the first study, Alqassab (2016) investigated the impact of peer feedback training on students’ beliefs about peer feedback provision, including learning from peer feedback provision, having confidence regarding peer feedback provision, and engaging in reasoning during peer feedback provision. She found that such beliefs became less positive. In study 2, relations among these beliefs, students’ perceptions of peer feedback message, and peer feedback content were investigated. The accuracy of peer feedback was found to relate to confidence beliefs and perceptions. Also, emotions were investigated, revealing that the quality of peer solution might result in experiencing more curiosity during peer
feedback provision. Confusion and anxiety were negatively related to peer feedback accuracy, but only for the near-correct peer solution condition. Students’ affect in peer feedback from the recipients’ perspective was investigated by Strijbos et al. (2010), showing that students who received elaborated specific peer feedback from a high competent peer experienced more negative affect.

7. **Interpersonal variables.** There were two interpersonal variables investigated in the current research: social aspects (e.g., trust) and anonymity. This is still an understudied area in peer feedback. However, interest in the peer assessment field in the social aspects and effects of anonymity has been increasing in the last decade. A significant milestone was the publication of the review from Van Gennip et al. (2009), followed by an updated review that summarized the results from an increased number of studies (Panadero, 2016). This last review concluded that formative approaches to peer assessment, the ones that are focused on providing more informative feedback than a score, might have better interpersonal results and seemed to be better received by the students. This represents an argument in favor of peer feedback and formative peer assessment rather than peer scoring. To our knowledge, only the work by Rotsaert (2017) has explicitly explored the effects of social aspects and anonymity on peer feedback in peer assessment situations. Even though the first and second study of Rotsaert’s dissertation explored interpersonal factors, it was done in relation to other peer assessment features; we will not explore them further here. The fifth study (Rotsaert et al., 2017c) explored anonymity effects, finding that there were no differences in the peer feedback quality in the anonymous phase as compared
to the non-anonymous one. Additionally, the third study at Rotsaert’s (2017) found that students preferred non-anonymous teacher feedback. With all this in mind we want to bring forward an important reflection and leave the reader with it.

“… the use of anonymity has to be considered carefully in terms of the learning benefits, if any, that it could produce (i.e., while anonymity may help assessors focus more on the content than the person who created the work, potentially decreasing bias, it is unknown if feedback written anonymously without much consideration of the recipient is as effective at connecting with the person and inspiring appropriate action to improve).” (Panadero, 2016, p. 262-263)

**Effects of Peer Feedback on Achievement**

A limited number of studies has explored whether implementing peer feedback has an effect on students’ performance. The results from the above-mentioned dissertations are mixed. One study showed no effects of the peer feedback intervention on performance (Gielen, Peeters et al., 2010). Two studies reported that it was the effect of peer feedback practice that enhanced performance rather than the scaffolding itself (Gielen & De Wever, 2012, 2015c). Finally, one study illustrated differential effects of the quality of the peer solution (the students provided feedback on) on their comprehension of the mathematical proof (Alqassab, 2016). Other studies have also found support for peer feedback effects on students’ performance (e.g., Cho, Cho, & Hacker, 2010, Cho & MacArthur, 2010). Li, Liu, and Steckelberg (2010) found that the quality of the feedback provided by the assessor increased students’ performance. This relationship was not found when the quality of feedback received by the assessee was explored. In this case, providing feedback (i.e., being an assessor) had a positive effect
that receiving (i.e., being an assessee) had not. Therefore, it seems that peer feedback has a positive effect on achievement amplified by practicing peer feedback provision\textsuperscript{4} and adequately implemented interventions.

**Conclusions**

In this chapter, we performed a thematic review of the field that is growing exponentially, as shown by the five dissertations’ publication dates. Peer feedback is a field that is promising for enhancing students’ achievement, as providing effective feedback can be of benefit to both the provider and the receiver of feedback. From the seven identified themes, a number of conclusions can be drawn. First, studies demonstrate that peer feedback can be of similar quality to teachers’ feedback because it includes features that are not present in teachers’ feedback. Peer feedback covers innovative aspects and is written in an easier language and from a non-expert who faces the same challenges. Second, peer feedback quality can be enhanced by scaffolding interventions (e.g., scripting the steps for an assessor), even though these interventions have not been always successful and future work is needed on when and how they work. Third, as proposed here, the domain knowledge should be considered using a developmental skill approach, in which students are given several opportunities for practice (Panadero et al., 2016). This approach has shown to be effective in providing better quality peer feedback as the effect of practice does make a difference in the existing literature. Fourth, areas that need more attention are the role of beliefs and emotions on peer feedback content, social aspects of peer feedback, and disentangling the effects of anonymity. For these research purposes, peer feedback could benefit from the growing body of knowledge from peer assessment literature and the existent empirical reviews (e.g. Panadero, 2016; van Gennip et al., 2009). Fifth, there is a

\textsuperscript{4} Though probably peer feedback reception also benefits from practice there is not solid empirical evidence yet. More attention needs to be paid by future research.
significant number of studies on students’ perceptions of peer feedback. While this research has important implications, it would be crucial to incorporate more objective measures of peer feedback impact that do not just ask for students’ perceptions to move the field forward. Finally, and most importantly, the research shows that peer feedback does not per se have an effect on students’ achievement and that the conditions for its implementation are crucial to obtain positive outcomes. In conclusion, it is clear that we have achieved some promising results in the incipient peer feedback research. Now is the time to increase our knowledge on peer feedback to determine key variables that affect its efficacy, or, simply put, to understand when, how, and for whom it works.
Formative peer feedback

References

Alqassab, M. (2016). Peer feedback provision and mathematical proofs: Role of domain knowledge, beliefs, perceptions, epistemic emotions, and peer feedback content. (Doctoral thesis), Ludwig-Maximilians University, Munich, Germany.


Gielen, M. (2016). *The impact of structuring peer feedback in a wiki-based CSCL environment on performance and feedback content.* Faculty of Psychology and Educational Sciences, Ghent University, Ghent, Belgium.


Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback


Rotsaert, T. (2017). *The social nature of peer assessment in secondary and higher education. Examining students’ perceptions on interpersonal processes and peer feedback quality in anonymous face-to-face settings using Mobile Response Technology*. (Doctoral thesis), Ghent University, Ghent, Belgium


