


Audio peer feedback to promote deep learning in online education

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Abstract

We investigated the relation between providing and receiving audio peer feedback with a deep approach to learning within online education. Online students were asked to complete peer feedback assignments. Data through a questionnaire with 108 respondents and 14 interviews were used to measure to what extent deep learning was perceived and why. Results support the view that both providing and receiving audio peer feedback indeed promote deep learning. As a consequence of the peer feedback method, the following student mechanisms were triggered: “feeling personally committed,” “probing back and forth,” and “understanding one's own learning process.” Particularly important for both providing and receiving feedback is feeling personally committed. Results also show that mechanisms were a stronger predictor for deep learning when providing than when receiving. Given the context in which instructors face an increasing number of students and a high workload, students may be supported by online audio peer feedback as a method to choose a deep approach to learning.

KEYWORDS

audio, deep approaches to learning, online learning, peer feedback, teaching/learning strategies

1 | INTRODUCTION

Higher education aims to promote a deep approach to learning among students and increasingly provides education online. Interaction in online education usually takes place in a written way due to the demand for student participation that is independent of space and time. In this respect, previous research (Filius, de Kleijn, Uijl, Prins, van Rijen, & Grobbee, 2018b; Planar & Moya, 2016) has shown that written peer feedback may be suitable for promoting a deep approach to learning within online education. From face-to-face education, we know that oral interaction plays a major role in promoting a deep

approach to learning, such as by creating a free and open dialogue, critical debate, negotiation, and agreement (Filius, de Kleijn, Uijl, Prins, van Rijen & Grobbee, 2018a, Fink, 2003; Garrison & Kanuka, 2004; Osman & Herring, 2007). Moreover, it can be perceived as more personal (e.g., Gould & Day, 2013). Therefore, in online education, audio peer feedback may, just as written peer feedback, also have potential for promoting a deep approach to learning by introducing oral interaction.

It is known from previous research that audio feedback has advantages over written feedback, such as a more personal experience (Kirschner, van den Brink, & Meester, 1991), more detailed and

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supportive feedback (Gould & Day, 2013), more possibilities for nuances, and more depth (Merry & Orsmond, 2008). However, the audio feedback in these studies had been provided by instructors, not by peers. And, partly as a result of this, these studies focused on receiving peer feedback rather than providing peer feedback. Therefore, in this current study, we will examine providing and receiving audio peer feedback to promote a deep approach to learning in online education.

2 | PROMOTING A DEEP APPROACH TO LEARNING THROUGH ONLINE AUDIO PEER FEEDBACK

2.1 | Deep learning outcome

Student approaches to learning tend to be dichotomized into deep and surface approaches. High-quality learning outcomes, such as analytical and conceptual thinking skills, may not be achieved unless students are encouraged to adopt deep approaches to learning, according to the research of the past 25 years (Biggs, 1999; Marton & Säljö, 1997; Prosser & Trigwell, 1998). Students who take a deep approach have the intention of understanding, engaging with, operating in, and valuing the subject. Such students take a broad view, think critically, relate new ideas to everyday experience, relate ideas to each other, and create new concepts. They tend to study beyond the course requirements.

Students who take a surface approach tend not to have the primary intention of becoming interested in and understanding the subject, but rather, their motivation tends to be that of jumping through the necessary hoops in order to acquire the mark, the grade, or the qualification. They try to learn in order to repeat what they have learned, memorize information needed for assessments, and tend to stick closely to the course requirements.

2.2 | Online education

Students can be influenced in their choice for a learning approach through the learning context, including teaching methods, curriculum, and assessment (Biggs, 1987; Hall, Ramsay, & Raven, 2004; Warburton, 2003). In online education, the learning context is different from face-to-face education. Usually, students who choose online education are not able or willing to visit the university, due to living abroad and/or having other responsibilities. As a consequence, all contact between students and their instructor takes place online. In a face-to-face environment, there are social cues that can be read by the instructor to indicate that, for example, students do not understand the feedback given to them. These opportunities for understanding feedback are not always present in an online context, which reduces the possibility for students to misinterpret feedback and hinders their ability to revise their work according to instructor expectations (Vaughan & Uribe, 2016). Therefore, as the demand for online education increases, there is a need to explore teaching

methods that instructors can use in online education to promote a deep approach to learning.

2.3 | Audio peer feedback

One of the teaching methods that instructors can use to influence the learning approach that students choose is peer feedback. Feedback can lead to the development of higher order skills (Snowball & Mostert, 2013). According to Nicol, Thomson, and Breslin (2014), providing and receiving peer feedback involve different learning benefits and processes. Peer feedback helps recipients to develop skills for reflection, self-regulation, and critical thinking (Boud, 2001; Dochy, Segers, & Sluijsmans, 1999; Ion, Sánchez Martí, & Morell, 2019; Sadler & Good, 2006). However, the effect of peer feedback depends on the way it is perceived, its acceptance by the recipient, and the willingness of the recipient to respond to the feedback (Ilgen, Fisher, & Taylor, 1979; Sadler, 2010). Students may lack the competence or expertise to provide peer feedback effectively, or their peers may perceive, rightly or wrongly, that they lack the expertise (Panadero, 2016; Zhu & Carless, 2015). Students may also not take the task seriously or be fully engaged in peer feedback (McConlogue, 2015). Consequently, as students do not trust their peers' expertise blindly, students question feedback from peers more than they would when the instructor provided this feedback (Gielen, Peeters, Dochy, Onghena, & Struyven, 2010; Yang, Badger, & Yu, 2006). Interestingly, it seems to provoke a deep approach to learning precisely because of the fact that the feedback is given by a peer (Filius et al., 2018b; Gielen et al., 2010; Yang et al., 2006). This may explain why feedback of low-competence peers is just as effective as feedback of high-competence peers (Strijbos, Narciss, & Dünnebier, 2010). Further on, when students gain expertise and follow training, students may perceive the peer feedback as increasingly positive as result of increasing peer feedback quality (Huisman, Saab, van Driel, & van den Broek, 2018). For the provider, peer feedback helps to improve critical thinking (Ertmer et al., 2007; Lin, Liu, & Yuan, 2001), creating new concepts and connecting to what students already knew (Nicol, 2001). Van Popta, Kral, Camp, Martens, and Simons (2017) and Ion, Sánchez Martí, and Morell (2019) suggested that providing feedback triggers several cognitive processes, such as comparing and questioning ideas, evaluating, suggesting modifications and reflection, planning, and regulating one's own thinking, thinking critically, connecting to new knowledge, explaining, and taking different perspectives. As providing online peer feedback is part of a collaborative process, social processes may be triggered as well in order to benefit from peer feedback.

Feedback can be provided in several ways, such as in conversations, in written text, and with video or audio. In this study, we define audio feedback as a digital sound file containing formative oral feedback, sometimes accompanied by images. Asynchronous audio feedback by instructors has been well examined by researchers, usually in face-to-face education. Merry and Orsmond (2008) suggest that audio feedback is more understandable to students because they are

more used to information being conveyed as sound than as written words, possibly reflecting their increased use of multimedia technology in their lifestyles. Students perceive audio feedback to be more personal than written feedback (Gould & Day, 2013; Kirschner et al., 1991; Merry & Orsmond, 2008; Moore & Wallace, 2012; Rotherham, 2007; Voelkel & Mello, 2014) and associated with involvement and enhanced learning community (Ice, Curtis, Phillips, & Wells, 2007). They also experience it as more supportive (Gould & Day, 2013; Hennessy & Forrester, 2014), as it is associated with the perception that the instructor cares more about the student, and it is perceived as more “genuine” (Merry & Orsmond, 2008). Also, the majority of students valued audio feedback as more detailed, as there seems to be more room for elaboration (King, McGugan, & Bunyan, 2008; Lunt & Curran, 2010; Planar & Moya, 2016). In that regard, audio feedback has more depth, because possible strategies for solving problems are included, rather than just stating what the problems are. Moreover, audio peer feedback is perceived as clearer, as there are more possibilities for nuances by tone of voice (Rotherham, 2007; Tseng & Tsai, 2007; Voelkel & Mello, 2014).

2.4 | Student mechanisms triggered by feedback interventions

To increase the potential impact of peer feedback on a deep approach to learning, it is crucial to better understand which mechanisms affect learning and how these mechanisms can be supported (Gielen et al., 2010). Student mechanisms describe how students engage in learning activities, which largely determines the quality of the learning outcomes they attain (Vermunt & Verloop, 1999). They may thus be considered as the triggers for a deep approach to learning. All student mechanisms related to a deep approach to learning involve some type of interaction, as interaction is often considered as a prerequisite for a deep approach to learning (Cleveland-Innes & Emes, 2005; Garrison, Anderson, & Archer, 2000). Our previous study on the use of written asynchronous peer feedback in online education was based on individual interviews and a focus group. This study resulted in identification of four mechanisms by which a deep approach to learning can be achieved (Filius, de Kleijn, Uijl, Prins, van Rijen, & Grobbee, 2018c). This study will build upon these mechanisms. The first mechanism was “feeling personally committed,” which means that students are personally addressed and feel part of a group, which makes them accept feedback more easily. The second mechanism was “probing back and forth,” which describes the way students present ideas and receive feedback on these ideas by “ping-ponging” back and forth, which requires comparing and synthesizing information, drawing conclusions, and supporting conclusions. The third mechanism was “understanding one's own learning process,” which refers to how students understand what they have learned and what they still need to learn while applying new information in different contexts. Lastly, the fourth mechanism was “asking and providing relevant feedback,” which refers to learning how to ask and provide relevant feedback.

2.5 | Present study

We aim to investigate the use of asynchronous audio feedback by peers for students in online education when aiming for a deep approach to learning. The main research questions are the following:

1. To what extent do *providing* and *receiving* audio peer feedback in online education promote a deep approach to learning?
2. Which mechanisms lead to a deep approach to learning in online education?

We expect that the results support the view that audio peer feedback promotes a deep approach to learning for both providing and receiving peer feedback. We also expect to find the same mechanisms as found when using written peer feedback, but they may work differently, as students perceive audio peer feedback to be more personal than written feedback.

3 | METHODS

3.1 | Design and context

This is a mixed-method study using questionnaires with both open questions and closed questions with a 5-point Likert scale. Furthermore, retrospective in-depth interviews were conducted and analysed qualitatively.

Audio peer feedback has been implemented within two types of online education: small private online courses (SPOCs) and massive online open courses (MOOCs). The SPOC concerned three editions of a completely online course at Utrecht University, the Netherlands. In the first edition, students were given four individual peer feedback assignments: two written and two audio feedback assignments. In course evaluations, the students and instructor indicated that the number of peer feedback assignments puts too much pressure on the time available. Therefore, in the second and third editions, students were given one written and one audio peer feedback assignment. The MOOCs concerned three editions of the MOOCs—Clinical Epidemiology, Human Rights for Open Societies, and Understanding Child Development: From Synapse to Society—at Utrecht University, the Netherlands.

3.2 | Participants

In order to review the peer feedback, students were asked to fill in an online questionnaire after the assignments. Of all 800 students who completed the assignments, 13.5% filled in the online questionnaire. Of the 108 students, 75.2% ($n = 85$) of the students both provided and received peer feedback, 10.6% ($n = 12$) of the students only provided peer feedback, and 9.7% ($n = 11$) of the students only received peer feedback.

The students (68 females, 38 males, and two unspecified) had ages ranging from 20 to 60 years, with an average age of 32.20 years (SD :

7.78). Of all students, 63.0% (68) participated in an MOOC and 37.0% (40) participated in a SPOC. The students came from five continents (Europe, 59.3%; Asia, 20.4%; Africa, 8.3%; North America, 6.5%; and South America, 5.6%). For 34% of the students, this was their first online course, and 12% had participated in more than five online courses. On average, students had participated in 2.7 online courses (SD: 1.17). The distribution of students over the four courses was as follows: Public Health, 37.0%; Human Rights, 25.9%; Clinical Epidemiology, 20.4%; and Child Development, 16.7%. To the best of our knowledge, both SPOC and MOOC students did not communicate face to face.

At the end of the course, all SPOC students from the first and second editions were invited for an interview. From these 25 students, 14 agreed and were interviewed. MOOC students were not invited for an interview because of feasibility reasons. Data analysis of the interview content indicated that all themes reached saturation, meaning additional interviews would not likely add to the depth or breadth of the data.

3.3 | Measures

3.3.1 | A deep approach to learning

A deep approach to learning has been operationalized as the initiation of critical thinking (e.g., taking a broad view and critically evaluate concepts), integrating what the student is learning with what he or she already knows (e.g., relating new ideas to everyday experience and integrating new ideas into one own's cognitive structure) and making new connections (e.g., relate ideas to each other and creating new concepts). For each of the three items of a deep approach to learning (critical thinking, integrating prior knowledge, and making new connections), students were asked to what extent a deep approach to learning was achieved, choosing from the following answers: *strongly disagree* (1), *disagree* (2), *neutral* (3), *agree* (4), *strongly agree* (5), *not applicable* (0). This is presented in Table 1.

As a measure for a deep approach to learning, we used the three items of a deep approach to learning separately in the first research question and all three together as "deep learning average" in the second research question. Cronbach's alpha for providing peer feedback

TABLE 1 A deep approach to learning questionnaire

Please answer each question with one of these answers: strongly disagree, disagree, neutral, agree, strongly agree, not applicable:
The peer feedback that I provided/received helped me to:
<ul style="list-style-type: none"> • Think critically; • Integrate new information with what I already knew; • Make new connections between different pieces of information and concepts.
Would you like to comment on or explain the above-mentioned answers?

Only the applicable option was requested.

TABLE 2 Mechanisms questionnaire

Please answer each question with one of these answers: strongly disagree, disagree, neutral, agree, strongly agree, not applicable:
The peer feedback that I provided/received helped me to:
<ul style="list-style-type: none"> • Feel personally connected to my peers/fellow learners; • Be involved in a dialogue with my peers; • Understand my own learning process.
Would you like to comment on or explain the above-mentioned answers?

was $\alpha = .94$ and for receiving peer feedback $\alpha = .87$, which is considered acceptable to good.

3.3.2 | Mechanisms

We measured three student mechanisms that can be triggered by feedback to lead to deep learning, which are feeling personally committed, probing back and forth, and understanding one's own learning process. Students were asked to what extent items have been achieved, as shown in Table 2. Because the questions concerning the mechanism "asking and providing relevant feedback" turned out to be ambiguities, we did not include the results of this mechanism in the analysis.

In order to map the students' perceptions, students were asked in both the questionnaire and interviews for underlying reasons and mechanisms that have been triggered in order to promote deep learning. The interviews allowed deeper probing into perceived differences between written and audio feedback reviews. Students were asked in which situations they learned deeply, what happened to them in order to achieve that result, and why. To encourage discussion, a semistructured interview sheet was used for all interviews, which contained the questions as shown in Appendix A. A first coding scheme was derived from our previous study for written peer feedback (Filius et al., 2018b). Next, the answers to the open question in the questionnaire and the transcripts of the interviews were deductively coded by using the three mechanisms, while keeping an eye open for possible additional mechanisms. This led to minor revisions of the coding scheme. The final scheme is shown in Table 3.

3.4 | Procedure

After each assignment, students were engaged in peer feedback in three steps, as shown in Figure 1.

Step 1 consisted of feedback instruction, in which students were told in both text and video how to aim their feedback specifically at a deep approach to learning. They were asked to provide feedback, including asking the right follow-up questions. Students were also shown examples of feedback aimed at a deep approach to learning (as a good example) and examples not aimed at a deep approach to learning (as a plausible bad example). Thereafter, the students were

TABLE 3 Mechanism codes

Mechanisms and their labels	Description
Mechanism "Feeling personally committed"	
Get to know each other; bonding	<i>The extent to which getting to know each other in the feedback assignment influences the achievement of deep learning, including references to the mutual atmosphere and compliments.</i>
Feel vulnerable	<i>The extent to which feeling vulnerable because of the feedback assignment influences the achievement of deep learning.</i>
Improve motivation	<i>The extent to which feeling more motivated because of the feedback assignment influences the achievement of deep learning.</i>
Mechanism "Understanding one's own learning process"	
Compare own arguments/ assignment with that of the peer	<i>The extent to which the feedback interventions influence the achievement of deep learning by stimulating you to see visions of others that clarify where you are in your own learning process.</i>
Use diverse learning preferences	<i>The extent to which the feedback interventions influence the achievement of deep learning by using diverse and different types of learning preferences.</i>
Mechanism "Probing back and forth"	
Interact quickly versus asynchronously	<i>The extent to which interacting asynchronously influences the achievement of deep learning and whether it is possible to prompt and probe in an asynchronous interaction.</i>
Ask in-depth questions and formulate suggestions	<i>The extent to which feedback interventions influence the achievement of deep learning by asking in-depth questions and formulating suggestions.</i>
Question each other, two-way	<i>The extent to which feedback interventions influence the achievement of deep learning by questioning each other, through a dialogue that has an effect on both sides.</i>
Ability to be clear, because of elaboration or tone of voice	<i>The extent to which feedback interventions influence the achievement of deep learning by being able to express yourself more clearly, because of elaboration or tone of voice.</i>

reminded of the content of the video during different parts of the course.

In Step 2, students were asked to provide feedback where they could choose between an audio or video way. Next, they were asked to record and upload their file and to share their file within the virtual

learning environment. Peer feedback was recorded by the students in different formats (e.g., audio, video with or without talking head, and video with or without slides) and published in the virtual learning environment using different methods (e.g., SoundCloud, YouTube, and PowerPoint), because the virtual environments that were used did not have a built-in recording functionality for audio or video feedback. After publishing, students had to paste the URL into the virtual learning environment.

In Step 3, students received a notification once the peer feedback on their own assignment was uploaded by a peer, and they were asked to look at and listen to their feedback carefully.

After these three steps, the students were asked to fill in the questionnaire about the peer feedback that they received. The concepts used, such as the measures of a deep approach to learning and the mechanisms, were explained again, similar as during the instruction. In the SPOC, feedback was not anonymous, and providers could see the answers on the questionnaire by the feedback receivers. In the MOOC, all feedback was anonymous.

After Step 3, interviews were conducted. Interviews and the open questions were used to ask for underlying reasons and mechanisms that were triggered in order to promote a deep approach to learning. The interviews allowed for deeper probing into the mechanisms that were triggered by the peer feedback, as well as exactly how they were triggered.

To ensure quality in all steps described, an audit was conducted by an independent researcher in order to validate the data collection, analysis, and synthesis of this study (Akkerman, Admiraal, Brekelmans, & Oost, 2008; de Kleijn & van Leeuwen, 2018). The audit had both a formative and a summative function. This resulted in an audit report with questions and answers. Questions concerned mainly the type of analysis that we chose. After writing answers to these questions in a satisfactory manner, the auditor reviewed the study again and affirmed it as being comprehensible, transparent, reliable, and valid. According to the auditor, decisions are explicated and communicated, decisions are substantiated, and decisions are acceptable according to standard values and norms.

3.5 | Analysis

3.5.1 | Research Question 1

In order to answer the first research question on the extent to which a deep approach to learning was promoted, descriptive statistics, such as the means and standard deviation, were calculated. We applied the paired samples *t* test with an alpha level of .01 to the frequency of all deep learning items (critical thinking, connecting concepts, and creating new concepts) between themselves to determine whether, and if so which, items differ significantly. We also applied the paired samples *t* test between providing and receiving for each item separately and for all deep learning items on average ("deep learning average"). Differences were reported only if statistically significant at $p < .01$.

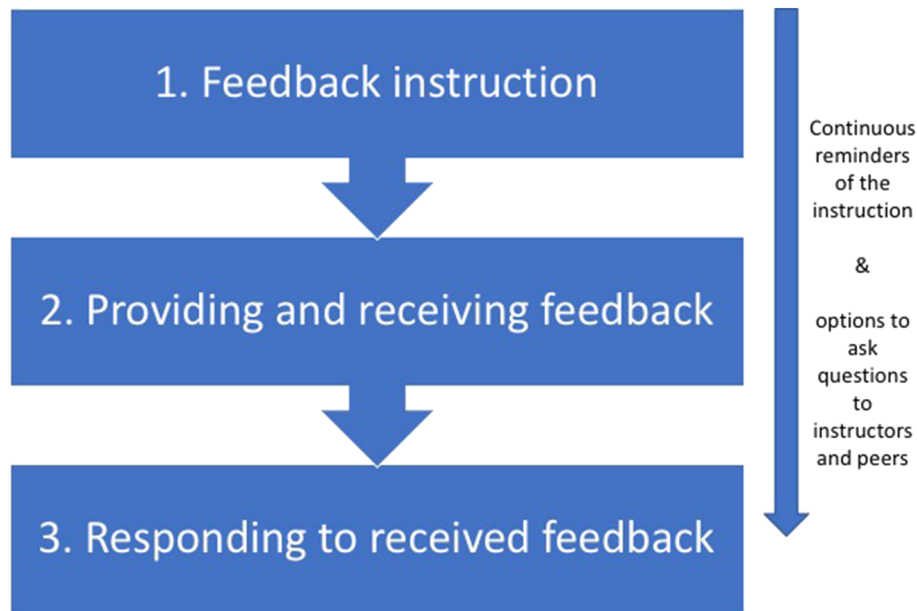


FIGURE 1 Three steps of the intervention [Colour figure can be viewed at wileyonlinelibrary.com]

3.5.2 | Research Question 2

To answer the second research question on the mechanisms that lead to a deep approach to learning, several types of analyses were conducted. First, descriptive statistics, such as the means and standard deviation, were calculated. We applied the paired samples *t* test with an alpha level of .01 to the frequency of all mechanisms (feeling personally committed, probing back and forth, and understanding one's own learning process) between themselves to determine whether, and if so which, items differ significantly.

Next, to assess the size and direction of the linear relations between the mechanisms and a deep approach to learning, a bivariate Pearson's product moment correlation coefficient (*r*) was calculated. To estimate the proportion of variance in a deep approach to learning that can be accounted for by the mechanisms, a standard multiple regression analysis was performed. Next, a standard univariate regression analysis was performed to estimate the proportion of variance in a deep approach to learning that can be accounted for each of the mechanisms separately. Scores were calculated using two-tailed, paired samples *t* tests with an alpha level of .05.

Also, we explored the additional predictive value of the following background and context variables: the gender and age of the students, the specific course they participated in, their experience with online learning, the continent that they are from, and the type of online education: MOOC or SPOC.

Thereafter, to measure whether the linear model matches the results obtained, we conducted a test for linearity by calculating a bivariate Pearson's product moment correlation coefficient (*r*). To explore the robustness of the results, analyses were performed both listwise and pairwise, and with and without imputed missing data with a series mean. To measure whether dichotomous scales will give different results on the relation between the mechanisms and a deep approach to learning than the original continuous scale, such as in case

the group that scores "very high" is different from the group of students that scores "low," "neutral," or "high," we dichotomized the data in different ways. If any discrepancies occurred between the different modes of analyses, they will be reported.

To explore underlying reasons that explain why the mechanisms lead to a deep approach to learning or not, we analysed the open questions in the questionnaires and the interviews. We analysed the interviews using thematic analysis and iterative coding in order to see whether the previously found mechanisms regarding written peer feedback could be verified (Filius et al., 2018c). Transcripts of the interviews were read thoroughly to ensure understanding of their content and to assign codes to text segments. Then, codes were developed based on constant comparison and contrasting of data across the different interviews (Miles & Huberman, 1994). To enhance reliability in coding, an independent researcher also analysed a random sample of approximately 10% of the data for calculating the interrater reliability. The percentage of agreement was 80%. Internal validity was further enhanced due to the description of the results, which were context rich and meaningful.

Table 4 visualizes the analysis of the data and the aims of all tests.

4 | RESULTS

4.1 | A deep approach to learning

Results in Table 5 show that, as expected, both providing and receiving audio peer feedback lead to perceived a deep approach to learning, as each of the three items has mean scores ranging between 3.80 and 4.02.

For providing peer feedback, "thinking critically" is higher than "integrating new knowledge with prior knowledge," $t(95) = 2.598$, $p > .01$. For receiving peer feedback, "thinking critically" is higher than

TABLE 4 Analysis

Data source	Analysis	Analysis aims
RQ1 Questionnaire	Paired samples t test	- To determine whether, and if so which, items differ significantly in comparison with each other - To determine differences between providing and receiving feedback
RQ2 Questionnaire & interviews Questionnaire	Paired samples t test	- To determine whether, and if so which, items differ significantly in comparison with each other - To determine differences between providing and receiving feedback
	Regression tests	- To explore the relation between the mechanisms and deep learning average and to determine whether, and if so which, items differ significantly in terms of their predictive power - To explore the influence of other determinants, namely the sex and age of students, the specific course they participated in, their experience with online learning, the continent that they are from, and the type of online education: MOOC or SPOC
	Thematic analysis and iterative coding	- To explore underlying reasons that explain why the mechanisms lead (or not) to deep learning

TABLE 5 Deep approach to learning items

Deep approach to learning	Providing		Receiving	
	M	SD	M	SD
Thinking critically	4.00*	(0.75)	4.02*	(0.88)
Integrating new knowledge with prior knowledge	3.89	(0.72)	3.84	(0.81)
Making new connections	3.96	(0.72)	3.80	(0.88)
Deep learning average	3.94	(0.69)	3.82	(0.90)

*Measure of deep learning that is significant higher than other measure(s) of deep learning.

both “integrating new knowledge with prior knowledge,” $t(93) = 2.821$, $p = .006$, and “making new connections between different pieces of information and concepts,” $t(93) = 3.138$, $p = .002$.

4.2 | Mechanisms leading to a deep approach to learning

4.2.1 | Relation between a deep approach to learning and mechanisms

As represented in Table 6, all three mechanisms were triggered, as the average score varies between 3.65 and 4.04 on a 5-point Likert scale.

We calculated the bivariate correlation between each of the mechanisms and a deep approach to learning, as shown in Table 7. This was positive and rather strong, ranging between .41 and .76 for providing

TABLE 6 Mechanisms

Mechanisms	Providing		Receiving	
	M	SD	M	SD
M1: Feeling personally committed	4.04	(0.69)	3.76	(0.80)
M2: Probing back and forth	3.65	(0.82)	3.68	(0.85)
M3: Understanding one's own learning process	3.75	(0.80)	3.66	(0.82)

TABLE 7 Pearson correlations among each mechanism and deep learning (N is 97 when providing and 94 when receiving peer feedback)

	Providing				Receiving			
	DLP	M1	M2	M3	DLR	M1	M2	M3
DLP average	—	.47*	.41*	.76*	—	.70*	.65*	.63*
M1: Feeling personally committed	.47*	—	.73*	.45*	.70*	—	.84*	.82*
M2: Probing back and forth	.41*	.73*	—	.64*	.65*	.84*	—	.84*
M3: Understanding one's own learning process	.76*	.45*	.64*	—	.63*	.82*	.82*	—

*Correlation with other deep learning item(s) is significant at the 0.01 level (two-tailed).

and between .63 and .70 for receiving. Results show that all mechanisms also correlate with each other, with p ranging between .41 and .73 for providing and between .63 and .84 for receiving.

A multivariate regression analysis shows that in combination, the three mechanisms accounted for a significant percentage of the variability in a deep approach to learning, both for providing (64%) and for receiving (54%) audio peer feedback. Thus, the predictive value of the mechanisms is greater for providing feedback than it is for receiving feedback. Regression coefficients for each predictor in the regression model are reported in Table 8.

The mechanisms “feeling personally committed” and “understanding one's own learning process” are significant predictors of a deep approach to learning when both providing and receiving peer feedback. More specifically, “understanding one's own learning process” is the strongest predictor when *providing* feedback, whereas “feeling personally committed” is the strongest predictor when *receiving* feedback.

TABLE 8 Regression analysis for mechanisms predicting deep learning (N is 97 when providing and 94 when receiving peer feedback)

Mechanisms	Providing			Receiving		
	B	SE B	β	B	SE B	β
Feeling personally committed	.40**	0.09	.40*	.36**	0.27	.37*
Probing back and forth	-.36**	0.09	-.42*	.09	0.14	.10
Understanding one's own learning process	.73**	0.07	.85*	.28*	0.14	.30*
R ²	.65			.54		
F	58.70**			34.80**		

*Correlation is significant at the 0.01 level (two-tailed).

**Correlation is significant at the 0.05 level (two-tailed).

Remarkably, the mechanism “probing back and forth” differs from the other mechanisms, as it is negatively correlated when providing feedback and not significant when receiving feedback. This mechanism is correlated with both deep learning and the other mechanisms for both providing and receiving.

p values were similar when we analysed listwise or pairwise, when we implemented missing data, or when we dichotomized the data, which shows the robustness of the results.

4.2.2 | Comparison of the mechanisms

Providing and receiving scores were compared for each of the mechanisms of both providing and receiving audio peer feedback ranging from 83 to 84 students. From the three mechanisms, only for “feeling personally committed” was the score for providing peer feedback significantly higher than for receiving peer feedback, $t(82) = 3.313$, $p = .001$.

When comparing the mechanisms within the category of providing, the mechanism “feeling personally committed” scores statistically significantly higher than “probing back and forth,” $t(96) = 6.777$, $p < .001$, and “understanding one's own learning process,” $t(96) = 3.599$, $p = 0.001$.

4.2.3 | Underlying reasons

Results from interviews and open questions reveal the underlying reasons for the student mechanisms. Examples for each code are shown in Table 9. Results show that students *feel personally committed* when they get to know each other better and it improves their motivation. Audio and video peer feedback resembles the classroom experience. However, in order to provide and receive peer feedback, you have to open up. Students reported that this also makes them feel vulnerable. A few students indicated that for this particular reason, they feel uncomfortable providing and receiving audio feedback.

Students feel that they better *understand their own learning process*, which leads to a deep approach to learning, when the peer feedback

TABLE 9 Examples from mechanism codes

Mechanisms and their labels	Example from data
Mechanism “Feeling personally committed”	
Get to know each other; bonding	“It makes you feel more connected to your peers.”
Feel vulnerable	“I did not feel very comfortable using this medium of communication.”
Mechanism “Understanding one's own learning process”	
Improve motivation	“Although putting an audio feedback was more challenging, it made you more committed to finish it, edit well, and speak clearly because it was more personal than a typed response.”
Mechanism “Probing back and forth”	
Compare own arguments/ assignment with that of the peer	“One: you are seeing what other people have done, which is also not what you did, and two: you have to also read—sometimes you have to read into topics that have not been touched on clearly in the unit—and you have to ask the deeper or the smaller questions. But most of it for me is the excitement of seeing what other people have done.”
Use diverse learning preferences	“I appreciated the fact that I could do audio and video posts and reviews. This was the first time I was allowed, and I was very nervous the first time, but I did enjoy it.”
Mechanism “Feeling personally committed”	
Interact quickly versus asynchronously	“It would be even better if we could talk to each other synchronously, because then you can talk to each other and react directly.”
Ask in-depth questions and formulate suggestions	“She asked me a lot of really deep questions about statistics that I never even thought about. So I had to go and do a lot of reading.”
Question each other, two-way	“That was great to have the option of receiving a reaction from your feedback. So that will give you the opportunity next time if you have to give feedback to improve your feedback.”
Ability to be clear, because of elaboration or tone of voice	“The oral version of the feedback was great, because they could take more time to talk about what they wanted to tell you. Because sometimes orally, you have more, I would say, flexibility, and you have more room and then can explain more what you want to talk about.”

gives them the opportunity to compare their own assignment with the work of peers, as they mention in both interviews and open questions. This seems to be the case more when students provide feedback rather than receive it. Being able to see how other students have interpreted the assignment and what they have done differently

makes giving feedback at least as interesting as receiving it. Moreover, several students mention that the use of a different medium, namely, audio or video besides written text, makes them look at the assignment from a different perspective that depends on the background and specific knowledge of the peer.

In order to learn deeply, it helps students to *probe back and forth*. Using audio peer feedback helps them to question each other, elaborate, ask in depth-questions, and formulate suggestions. Students also mention that this mechanism would be triggered more if it was synchronous interaction. It would also be helpful if the virtual learning environment would allow students to continue the dialogue somewhat longer so that students could continue their conversation, either synchronous or asynchronous.

Some issues other than the mechanisms were raised during the interviews and in the open questions. Many students indicated that both recording and publishing take relatively much effort. A cause for that was that none of the virtual learning environments was specifically designed for this purpose. Another cause was that the majority of the students never had recorded, published, or listened to audio peer feedback before. Moreover, in the interviews and open questions, the majority of the students mentioned that they were not native English speakers. A considerable number of students indicated that they had difficulty talking in English and that they therefore recorded their feedback several times and/or wrote it out in advance.

5 | DISCUSSION

In this study, we investigated the relation between providing and receiving audio peer feedback with a deep approach to learning, on the one hand, and within online education, on the other. Results support the view that both providing and receiving audio peer feedback indeed promote a deep approach to learning. As a consequence of the peer feedback method, the following student mechanisms were triggered: “feeling personally committed,” “probing back and forth,” and “understanding one’s own learning process.” Particularly important for both providing and receiving feedback is feeling personally committed. Results also show that mechanisms were a stronger predictor for a deep approach to learning when providing than when receiving feedback. We will discuss the main findings of our study for each research question.

5.1 | To what extent do providing and receiving audio peer feedback in online education promote a deep approach to learning?

As expected, results support the expectation that audio peer feedback is an effective method to promote a deep approach to learning in online higher education. This is the case for each of the three elements of a deep approach to learning, which are “critical thinking,” “integrating new knowledge with prior knowledge,” and “making new connections between different pieces of information and concepts.” This is the case for both audio peer feedback receivers and providers.

In an earlier study on providing written peer feedback in online education, van Popta et al. (2017) and Ion et al. (2019) concluded that providing peer feedback has several potential learning benefits for the provider. Examples are higher level thinking, critical reflection, and insight, possibly caused by their active role in their own learning. This study adds that this also applies to audio peer feedback in online education. Providing and receiving peer feedback have an almost equal predictive value for achieving a deep approach to learning. According to the students who provide feedback, critical thinking is achieved in a stronger way than “integrating new knowledge with prior knowledge” and “making new connections between different pieces of information and concepts.” According to students who receive feedback, the three deep learning elements are equally achieved.

5.2 | Which mechanisms lead to a deep approach to learning in online education?

Results show that the combination of all three mechanisms, which are “feeling personally committed,” “understanding one’s own learning process,” and “probing back and forth,” leads to a perceived deep learning approach. Because the mechanisms are originally based on a study of written feedback, we suggest that audio and written feedback basically initiate the same student mechanisms and that there are only minor differences in the expression of the mechanisms, such as the emphasis on personal commitment to audio peer feedback in comparison with written feedback. We will now discuss each of the mechanisms successively.

The most predictive mechanism is *feeling personally committed*, which is triggered more by providers than recipients. This may be explained by the fact that in order to provide audio peer feedback, students naturally become involved in the content of the course and the response of the other student. However, comparing the three mechanisms when receiving feedback, this same mechanism of feeling personally committed is the strongest predictor of a perceived deep learning approach. We suggest that this indicates how important “feeling personally committed” is for audio peer feedback in general. The reason for this may be that the student, more than with written feedback, personally relates to the peer. This relationship makes students feel connected and may increase their motivation. This corresponds to earlier studies (e.g., Kirschner et al., 1991; Parkes & Fletcher, 2016) about the audio feedback receiver, but also appears to be true for the audio feedback provider. Thus, this study adds knowledge about the social processes to what van Popta et al. (2017) found about the cognitive processes that occur by providers within online education.

Looking more specifically at the feedback providers, the mechanism *understanding one’s own learning process* is triggered most in comparison with the two other mechanisms. We suggest that this is caused by critically looking at the assignment of another student, which provides the student with more understanding of one’s own learning process than just receiving feedback. For both providers and receivers of audio peer feedback, the fact that audio peer feedback is another medium may help them to understand their own learning

process, because the use of different media helps to see things from a different perspective. Audio feedback may also accommodate students with an audio learning preference (Merry & Orsmond, 2008; Morris & Chikwa, 2016).

The deviating results of the mechanism *probing back and forth* can be the result of a large overlap between the different mechanisms and their predictive value of a deep approach to learning. We hypothesize that once students feel more personally committed, they will also make more effort to prompt and probe, and as a result, they will better understand where they are in their own learning process. Conversely, if students better understand where they are in the learning process, prompting and probing will also be easier, and they will feel more personally committed. The prompting and probing will stimulate the feeling of personal involvement, but also the understanding of where they are within their own learning process. This overlap may consist of a generic element, which we suggest is the social interaction that takes place by providing and receiving feedback and has an important role in achieving a deep approach to learning (e.g., Ertmer et al., 2007). Nevertheless, social interaction will not always lead to a deep approach to learning. The mechanisms in this study indicate that social interaction considerably increases the likelihood of a deep approach to learning.

Considering the differences between providing and receiving feedback in relation to a deep approach to learning, the predictive value of the deep learning mechanisms was greater for providing feedback than for receiving feedback. This may be because feedback providers are more stimulated to feel personally committed than feedback recipients. Providing feedback requires the feedback providers to deepen themselves in the work of the other person. This is reinforced by pretraining on feedback skills aimed at a deep approach to learning. On the other side, the feedback recipient can receive feedback without deepening himself or herself. Whether deep learning takes place depends on, among other factors, the way the feedback is perceived, its acceptance by the recipient, and the willingness of the recipient to respond to the feedback (Ilgen et al., 1979).

5.3 | Practical implications

Based on our findings, we advise instructors to consider implementing audio peer feedback when they aim for a deep approach to learning for their online students in a scalable way. Well-implemented audio peer feedback may be attractive in involving students actively in applying criteria and reflecting on their own work. It can be part of practices that attempt to involve students actively in feedback processes and reduce unproductive and time-consuming instructor commentary. Moreover, students consider their involvement critical in the design and learning experiences (Ion et al., 2019), and providing peer feedback could positively attribute to this. It is however essential that the students understand the rationale for peer feedback and that they receive sufficient training on how to provide audio feedback aimed at a deep approach to learning. There are several conditions that instructors should take into account in their considerations. For example, the insight that providing peer feedback is just as important as receiving peer feedback

can be valuable in designing the learning process. But because providing feedback to peers is known to be difficult for students (Dochy et al., 1999; Ion et al., 2019; Topping, Smith, Swanson, & Elliot, 2000), it is worth investing the time and effort to implement it. This also means that it takes learning time for students to use audio peer feedback. Learning time for providing feedback was not mentioned in earlier studies on audio peer feedback. We therefore suggest that instructors should provide sufficient instruction about how to provide feedback aimed for a deep approach to learning and, more specifically, on how to record, publish, and listen to audio peer feedback.

Another condition that instructors can take into account is that all students have sufficient proficiency in speaking the language of communication in order to be able to provide feedback in an audio way. Audio peer feedback has shown to be a good addition to the already existing learning methods, which instructors may find useful in the pursuit of a wide variety of learning methods for students with different learning preferences.

On the basis of this study, we advise educational technology designers to design the learning environment in such a way that feedback can be directly recorded and published in the learning environment and, preferably, in such a way that a real dialogue can take place between the provider and the receiver. Results of this study suggest that audio peer feedback is well capable of promoting a deep approach to learning and that when technical barriers are fewer, the possibilities for deep learning approaches have great growth potential.

5.4 | Future research

Although the present study helps to illuminate our understanding of the use of audio peer feedback in online education, it has also raised new questions. For instance, in order to promote a deep approach to learning, a subsequent study could examine the extension of the (synchronous or asynchronous) dialogue with the aid of audio peer feedback, with more options for questioning and responding. The importance of a feedback dialogue for written peer feedback has been shown by other studies (e.g., Filius et al., 2018b; Boud & Molloy, 2013; Ruegg, 2015). This may enable further prompting and probing and deepen the interaction. Also, the study did not make a distinction between audio and video feedback and, more specifically, video in which facial expressions and social cues can be seen and that may stimulate the feeling of personal commitment. It may be interesting how the different types of feedback (typed, audio, and video) cause a direct and indirect effect on a deep approach to learning. The type of feedback may influence the degree of social presence, which is the degree to which “the other” in a communication appears to be a “real” person (Kreijns, Kirschner, Jochems, & Van Buuren, 2011). It is recommended that follow-up research should also take this into account, as social presence could perhaps trigger the mechanisms “feeling personally committed” and “probing back and forth.” Although social presence may depend on other aspects as well than only on the physical attributes of the feedback type, it may be even higher at video even more and thus promote a deep approach to learning even more (Vaughan & Uribe, 2016).

Next, we used self-reported data as a measure of a deep approach to learning. A disadvantage may be that students with an extreme opinion, in both directions, are more inclined to finish the questionnaire, resulting in a nonresponse bias. Moreover, self-reported data are often subject to subjectivity. Further research could use a different way of measuring a deep approach to learning to further underpin the results. However, comparing the educational outcome, for example, by comparing the grades, may not be a true measure. After all, students will usually adapt the quantity and quality of studying to meet testing requirements. In doing so, they may compensate for teaching quality and generate more effort (Ten Cate, 2001). Hence, grades should not be considered the primary outcome of teaching but the outcome of learning activities. Results could be triangulated by instruments other than feedback, such as collaborative assignments and online asynchronous discussions (Du, Harvard, & Li, 2005).

Lastly, it is recommended that follow-up research should include the influence of being a native speaker, as this may be an important factor for students who are asked to present their feedback orally.

5.5 | Conclusion

This study showed that audio peer feedback can lead to a deep approach to learning and that this is triggered by three mechanisms: "feeling personally committed," "probing back and forth," and "understanding one's own learning process." Also, these mechanisms are a greater predictor of a deep approach to learning when providing feedback than when receiving. Particularly important for both providing and receiving feedback is feeling personally committed. In addition, providing feedback gives students an insight into their own learning process, and consequently, they report learning deeply.

This study indicates that the various benefits of audio feedback by the instructor also apply to the provision of feedback by the peer. Moreover, it shows that providing this feedback is as valuable for achieving a deep approach to learning as receiving it. Given the need for deep approaches to learning and the context in which instructors are faced with an increasing number of students and a high workload, online audio peer feedback can thus be a valuable learning method to promote deep learning within higher education.

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CONFLICT OF INTERESTS

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- What feedback did you receive yourself (self-assessment/multiple-choice test and the 'reflection' learning activities)?
3. How did you experience the feedback?
 - Did you understand and accept the feedback that you received?
 - To what extent did the feedback stimulate you to deep learning? Why?
 4. Did you provide feedback yourself?
 - How did this go? Why?
 - What were your aims with the feedback?
 - Do you think that the feedback receiver understood and accepted the feedback? Why do you think so? What happened?
 - What did the feedback receiver do with the feedback? How do you know?
 - How did the feedback receiver value the feedback? How do you know?
 - Do you think that the feedback promoted deep learning? Why?
 5. How can we use feedback to promote deep learning in online education?
 - How can we ensure that new knowledge in this course is being connected to what the student already knows?
 - And that new concepts are being learned?
 - And that new connections are being created?
 - And that the course promotes critical thinking? How?
 - In your opinion, what causes deep learning to be reached or not be reached? Why is that so, do you think?
 - Did this work out well in this specific course, according to you? Why do you (not) think so?
 - What do you think is most important to the feedback that students received in this course? What problems did you experience? What do you think is difficult?
 - Do you have any other ideas about what could happen to reach deep learning through feedback in online education?
 - Suppose that you should formulate advice about providing feedback to promote deep learning in this specific course. What advice would that be?
 6. Closing
 - Are there any questions that you expected but that I did not ask?
 - What else would you like to say about feedback or deep learning?

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APPENDIX A

INTERVIEW QUESTIONNAIRE FOR STUDENTS

1. Please describe to what extent this course promoted deep learning for you and why
 - Did you have enough prior knowledge to participate in this course? Why do you think so? Could you give an example? Did you ever feel like you did not have enough prior knowledge? What exactly happened?
 - Did you connect new knowledge with what you already knew? Can you give an example? What exactly happened?
 - Did you learn new concepts? Which one(s)? What exactly happened?
 - Did you see new relations? When? Which one(s)? What exactly happened?
 - Did the course stimulate you to think critically? How?
2. Regarding the extent to which deep learning was promoted, what was the role of feedback (peer feedback, formative assessments, and instructor feedback)?
 - How?
 - What feedback did the instructor(s) give?
 - What feedback did the students give (to each other)?