Practising Feedback: Use of Role-play in Online Mathematics Teacher Education

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This paper discusses the use of role-playing in online mathematics teacher education for preparing pre-service secondary mathematics teachers to use formative feedback. Findings from video-recorded role-plays and participant reflections highlight how the context presented in the online role-plays can enable or restrict different feedback types. The study also reveals that the online environment supports feedback training but limits participants’ ability to express feedback. The paper offers suggestions to enhance the potential of online role-playing for feedback training.

In mathematics teacher education (MTE), a practice-based approach emphasizes recurring practical training, immersing pre-service teachers in real teaching situations (Ball & Cohen, 1999). This approach aims to enhance teaching skills through hands-on experiences during field placements and approximated mathematics teaching scenarios within university courses like role-playing, video observation, and co-teaching in controlled settings (Grossman et al., 2009). While previous research has verified the benefits of a practice-based approach to MTE when employed in campus-based settings, a review of research on practice-based teacher education (Matsumoto-Royo & Ramírez-Montoya, 2021) shows no examples of studies in online settings.

One thing MTE should include is preparing pre-service teachers to provide feedback on pupils’ thinking. Assessment and feedback on pupil understanding are crucial for pupils’ learning, and effective formative feedback significantly enhances pupil achievement (Anthony & Walshaw, 2009; Hattie & Timperley, 2007). Despite its potential, reports reveal shortcomings in feedback quality given by teachers to pupils (e.g. Hirsh & Lindberg, 2015; Stovner & Klette, 2022). Consequently, pre-service teachers are unlikely to encounter feedback practices advocated by research during their field placements.

The focus of this paper is the implementation of a practice-based approach in online MTE, using the case of pre-service teachers’ opportunities to express and utilize different types of feedback to prepare for mathematics teaching, in education where the pre-service teachers are not physically present for face-to-face interactions. One effective method for preparing pre-service teachers for demanding teaching situations, such as giving formative feedback in the moment, is to use role-playing (Lajoie, 2018). Based on this, the question to be answered is *What does role-play as an approximation of teaching offer online MTE in terms of training of feedback?* This will be answered by analyzing recorded online role-plays and the discussions about participants’ experiences of the role-plays.

## Previous research

In this section, previous research on practice-based MTE, online education, teaching approximations such as role-playing, and elements of a formative feedback process in mathematics teaching will be presented.

Practice-based MTE implies recurring training for pre-service teachers in real or made-up teaching situations, aiming to improve their teaching skills through hands-on experiences in field placements but also during university courses in approximated mathematics teaching scenarios (Ball & Cohen, 1999). There are various examples of exercises that approximate teaching practices such as lesson planning, role-playing, co-teaching, and reflection writing (McDonald et al., 2013). One goal with approximations is to prepare pre-service teachers to make better decisions when facing teaching challenges (Lampert et al., 2013). Here, role-playing has been highlighted as a powerful approximation for training pre-service teachers to act in the moment (Lajoie, 2018). The relevance of role-play for such training is motivated by its authenticity in relation to the real teaching situation (Howell & Mikeska, 2021). Owing to the nature of approximations such as role-play, teaching situations can be simulated to prepare for mathematics teaching in a safe, controlled, and scaffolded environment with the support of a mathematics teacher educator (Grossman et al., 2009).

As more students enrol in online MTE programs (Dyment & Downing, 2020), questions arise about adapting practice-based MTE to virtual settings. Research has shown the benefits of this approach in campus-based contexts for both pre-service and novice in-service teachers (Kazemi et al., 2015; McDonald et al., 2013) but there is limited research on adapting practice-based approaches to online contexts (Matsumoto-Royo & Ramírez-Montoya, 2021). Nonetheless, online mathematics education encounters challenges related to instruction, interaction, and collaboration (Radmehr & Goodchild, 2022).

Among various teaching practices that are central to a mathematics teacher’s work, feedback on pupils’ learning emerges as one important practice (McDonald et al., 2013). Feedback can serve both summative and formative purposes, of which formative feedback is emphasized as particularly effective for pupils’ learning (Hattie & Timperley, 2007; Ryve et al., 2015). Formative feedback can be defined in different ways and in various contexts. In an educational context, formative feedback refers to information about pupils’ performance and learning that aims to enhance achievement and bridge the gap between actual and desired learning (Hattie & Timperley, 2007).

As a teacher provides feedback to a pupil in the classroom it involves some form of communication. For the pupil’s learning, it is important that the conversation focuses on the pupil and her ideas rather than having a teacher-centred approach (Hufferd-Ackles et al., 2004). Similar to the perspective of Ruiz-Primo and Li (2013), in this paper the feedback concept also encompasses the communication during which the teacher elicits the pupil’s thinking as a step towards providing feedback. This expansion of the concept of feedback means that both the acting teacher and the acting pupil become important for the analysis. A deeper explanation of what the feedback process covers in this paper will follow in the theory and methodology section.

Research has shown that formative feedback is something teachers spend much time on (Björklund Boistrup, 2022; Stovner & Klette, 2022), and the knowledge of the potential of formative feedback is well known (Hirsh & Lindberg, 2015). Despite this, research reports on deficient qualities in the feedback given (e.g. Hattie & Timperley, 2007; Hirsh & Lindberg, 2015; Stovner & Klette, 2022). Given this background, it is essential to examine feedback practice training when incorporating role-playing into online education within the context of MTE.

## Theory

The design of the study is informed by the experimental cyclic learning process theory as utilized by Kazemi et al. (2015). Kazemi et al.’s learning cycle involves four phases: (1) introduction to a teaching practice, (2) meeting for collaborative preparation, (3) practice enactment with pupils in a mathematics classroom, and (4) reflective analysis, which brings experiences into the next cycle. This paper reports on data from the enactment and analysis phase. To make the enactment phase fit the current study’s context, modifications were made. Instead of enacting the feedback practice in traditional classroom interactions in a school, participants engage in approximated teaching scenarios in an online environment where one of the participants acting as a pupil, replaces the authentic pupil. In this way, a recurring enactment by practising to provide feedback to pupils becomes enabled in online MTE even without access to a real classroom.

### The feedback process

Previous studies have delineated components of formative feedback, and selected parts of these theoretical contributions found relevant lend support to this study. The four categories, task focus, process focus, self-regulation focus, and self-focus, based on Hattie and Timperley (2007), capture some characteristics of expressed feedback, with process and self-regulation focused feedback being the most effective, while self-focused feedback is less efficient. However, combining self-focused feedback with task or process feedback can mitigate the negative effects of feedback about the individual, e.g., repeated praise (Hattie & Timperley, 2007). Feedback can be communicated using various expression forms, encompassing verbal communication, written text, laboratory materials, images, symbols, body language, and more (Björklund Boistrup, 2022). These expression forms are important in shaping the meaning of a discourse (Van Leeuwen, 2005). One expression form of feedback is also when teachers are being silent. Allowing the pupil more than three seconds to reply is rare among teachers but leads to improved quality and quantity of pupil responses (Björklund Boistrup, 2022; Rowe, 2003).

The communication between teacher and pupil during feedback processes varies and involves the pupil to differing extents. This study considers teacher-pupil communication as an integral part of the feedback process. Consequently, the framework integrates two levels of communication characteristics, drawing inspiration from Hufferd-Ackles et al. (2004). They advocate a transition from a teacher-centred to a more pupil-focused approach, promoting increased pupil engagement. Unlike Hufferd-Ackles et al., only levels 0 and 1 are used in this study, as levels 2 and 3 assume several pupils are involved. What defines level 0 and 1 is described later in this paper.

## Methodology

### Context and participants

The participants in the study are students taking their eighth semester in a Swedish online mathematics secondary teacher education. At the time of the study, these students were in a course bringing together pre-service teachers from various subjects. All three students specializing in mathematics consented to participate in the study. The two meetings for data collection, hereafter called activities 1 and 2, were separate from participation in the university course. To reduce power imbalance (Hayes et al., 2008), the researcher, who taught other students in the university course, was not involved in the three participants’ studies in the university course addressing the issue of dual roles.

### Design of activities

For data generation pertaining to the research question, during activity 1, different role-plays in which participants assumed the roles of either a teacher or a pupil were employed. The role-play session was preceded by an introduction to the subject of feedback through university course materials and a collaborative exchange of feedback ideas among the participants before they enacted their ideas in the role-plays. The role-plays were based on tasks from various areas of mathematics to show difficulties pupils commonly demonstrate in mathematics education (e.g., Di Lonardo Burr et al., 2020). The purpose of the choice of tasks was not to challenge the participants’ mathematical knowledge but to form a basis for feedback in mathematics teaching. Every role-play started with a moment of individual reflection on a given mathematical task and a fictional pupil’s associated written incorrect solution. Then, the acting teacher asked questions to the acting pupil to understand the pupil’s thinking and responded accordingly. It is worth noting that the role-play was not about acting as an actress, but expressing what is found appropriate for the task. Based on the recommendations of Shaughnessy and Boerst (2018), the acting pupil was told to be restrained with information and only answer what the teacher asked, to challenge the teacher’s eliciting skills. During the role-plays, the researcher coordinated, gave instructions, selected tasks, distributed roles, and allocated time between different exercises. During the analysis phase*,* activity 2, an online follow-up discussion a week later, the participants’ impressions about the possibilities and limitations of using role-play for feedback learning were collected.

### Data analysis

Video recordings of activities 1 and 2 were automatically transcribed with transcript software and then manually corrected. Parts particularly interesting for the research question were edited and cleaned, as a verbatim transcript was not considered useful for this paper. The data analysis aims to comprehensively address the research question through two different approaches. The first, a thematic analysis (Braun & Clarke, 2022) with a deductive orientation was employed to describe feedback expressed in the role-plays. For the deductive analysis, NVivo was used to pair text to seven preexisting codes linked to the feedback process (see pp. 3-4). Classification criteria for five of these codes are described in Table 1. Alongside these five codes, the teacher-pupil communication was coded at either *level 0* or *1*. At level 0 the teacher is telling and showing. The pupil is not expected to elaborate on the frequent and short questions, only reply with the expected answer. The pupil’s answers are not followed up by probing following-up questions. At level 1 the focus of the teacher’s questions has moved towards the pupil’s thinking. The teacher asks more probing questions, and the pupil becomes more involved and has an impact on his or her own learning.

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| **Codes** | **Criteria, characteristics** | **Example** |
| Task focus | Focuses on something specific in the task at hand. Corrects, without involving processes. Provides solutions. Gives advice leading towards a particular answer or strategy. | *Now, subtract 93 and 47, so first mark 93 on the number line.* |
| Process focus | Pays attention to process or strategy, beyond the task itself. Provides generalizable hints, even if they are targeted at the task. “Sketch a graph.” Asks for meanings and definitions of different concepts. Corrects, by involving processes. | *Why is it like that when you add fractions?* |
| Self-regulation focus | Provides feedback aimed at the pupil developing her ability to control her own learning. Supports the pupil to review and re-count solutions. | *Is the answer reasonable? Test your solutions* |
| Self-focus | Feedback only relates to the individual. | *Good job!* |
| Expression form | Besides verbally, feedback can be expressed by using or articulating the use or need of written text, symbols, pictures, images, laboratory materials, body language, or if the acting teacher stays quiet for over three seconds while waiting for the pupil to reply to a question. |

Table 1. Thematic framework for feedback process analysis, based on Björklund Boistrup (2022), Hattie and Timperley (2007), and Rowe (2003). Note that the codes for teacher-pupil communication (Hufferd-Ackles et al., 2004) are not displayed in the table.

The second approach captures the specifics of role-playing and its implementation in an online environment. An inductively oriented thematic analysis was applied, discovering content that contributed to a deeper understanding of how role-playing in online MTE can serve as an opportunity to practice feedback. During an open coding process, each line and quotation was labelled pertaining to feedback, the online environment, and the role-play content of the transcripts.

Through the process of searching, reviewing, and refining patterns among the findings from the deductively and the inductively oriented thematic analysis, three themes emerged capturing meaningful data relevant to the research question: *Feedback independent of teaching-pupil information*, *Context-specific challenges*, and *Role-play- specific reflections*.

## Results

In this section selected results salient to each theme are presented.

### Feedback independent of teaching-pupil information

The analysis of the two recorded activities showed that throughout the various role-plays, there was no feedback expressed regarding self-regulation or the self as a person. This is probably connected with participant reflections on the lack of context such as knowledge of the pupil and specific goals. Namely, the instructions for each role-play did not provide information about goals or the fictional pupil’s prior knowledge or social situation. Such information is what the name of this theme refers to as teaching-pupil information. However, at the same time, role-playing can lead to the utilizing of feedback focusing on both the task and the process. To the task with the incorrect answer, $93-47=54$, the acting teacher suggests the acting pupil use a number line.

Teacher: If you draw a number line? Can you calculate the same task with the number line? Could you explain to me step by step how to do it?

Pupil: What do you want me to count then? The difference between 3 and 7?

Teacher: No, 93 and 47, so mark 93 on the number line.

Pupil: Yes

Teacher: And then from 93 you need to subtract 47, but you don’t have to do it in one step. Ehm… without... How do you think you can easier subtract it on the number line?

In the initial part of the excerpt, the teacher’s feedback is task oriented, but it transitions to addressing the pupil’s understanding of subtraction on the process level in the final sentence. Despite the absence of knowledge about the pupil, the conversations within the role-plays can prioritize the pupils’ thinking. In the preceding passage, the communication occurs at level 0 up until the final sentence, at which point the teacher shifts to level 1. A more distinct illustration of communication at level 1 will be evident in the next role-play excerpt. To the incorrect solution, $\frac{2}{7}×\frac{3}{7}=\frac{6}{7}$ , the acting teacher probes the acting pupil’s approach by asking "What are you going to do, in the task?" It becomes clear that the pupil understands the need to multiply fractions but incorrectly believes that the denominators should remain the same when multiplying fractions with equal denominators. The teacher continues,

Teacher: Is it the same rule when adding fractions?

[Silence, 8 sec]

Pupil: Yes, I think so.

Teacher: Why is it like that when you add fractions?

[Silence, 5 sec]

Pupil: When we add the two?

Teacher: Yes, if there had been an addition sign instead of a multiplication sign?

Pupil: Since we have the same denominator then it equals... [short silence] ... five times...5 through 7.

Communication thus far is at level 1 and focused on processes, featuring an instance where the teacher employs silence. The teacher continues the feedback process by prompting the pupil to contemplate another multiplication, hoping this will lead to insights that assist in solving the initial problem. In contrast to the prior excerpt, the teacher now transitions to communication level 0 but maintains a process focus of the feedback. This feedback may also serve a self-regulatory purpose if the pupil can apply the strategy to solve similar, simpler problems.

### Context-specific obstacles

The teacher’s introduction of a number line in the first excerpt of the previous theme suggests an attempt to incorporate non-verbal forms of feedback. Later in that role-play, the pupil displays her attempt at a drawn number line in the webcam. Here, the limitations of the digital online environment are illustrated as efforts to transition between various forms of expression are impeded by contextual constraints. During the analysis phase, participants also acknowledged the limitations posed by the online context, especially when it came to mathematics instruction. The online environment was perceived as a safer space for role-play compared to in-person meetings, although gestures or facial expressions were difficult to interpret.

### Role-play-specific reflections

The participants viewed the role-plays as a valuable opportunity to practice teaching, asking questions, and providing helpful feedback that goes beyond simply describing rules or solutions. Participants also found value in exploring different forms of feedback and becoming more aware of their own feedback style. Among the participants, previous experiences of approximations of teaching were limited to reflexive writing and discussions about pupils’ written solutions. Additionally, suggestions from the participants were more time for discussion after every role-play and an actively participating mathematics teacher educator.

## Discussion

Initially, the question was asked: What does role-play as an approximation of teaching offer online MTE in terms of training of feedback? Communication during the feedback process was observed at level 0 and 1, with instances of participants transitioning between the two. In this way, the role-plays illuminate the communication characteristics as described by Hufferd-Ackles et al. (2004) in the feedback process. Shifting between communication levels may result from the focus on feedback in the role-plays, as participants viewed the role-plays as opportunities to test various feedback types. Participants also talked about limitations in providing feedback due to the limited knowledge of the fictional pupils and the scarcity of clear goals for the mathematics teaching situation presented in each role-play. These limitations may have contributed to the almost total absence of self-regulation and self-focused feedback. In contrast, the role-plays yielded repeated feedback on both the processes and the tasks. Creating informative contexts around the exercises and pupils’ situations may enhance the authenticity of role-plays, as Howell and Mikeska (2021) emphasize, which might improve the conditions for providing diverse and well-grounded feedback in these scenarios.

In the online environment, limitations became apparent when there was a need to use symbols spontaneously, and alternative means of expression beyond verbal communication were sought. These obstacles may arise from the specific demands of online mathematics teaching (Radmehr & Goodchild, 2022). Participants attempted diverse expression forms during the feedback process, including silence and visual aids like number lines, and expressed difficulties in interpreting body language. While these modes of expression align with the ideas of Björklund Boistrup (2022), Rowe (2003), and Van Leeuwen (2005) regarding the feedback process, they are constrained within the virtual environment. However, these challenges underscore the importance of preparing the exercises and exploring alternative digital resources, such as synchronous drawing tools, to facilitate diverse forms of expression.

Lampert et al. (2013) and Lajoie (2018) emphasize the importance of practising challenging parts of teaching and preparing to act in the moment. These opportunities can be seen in online role-plays as the acting teacher has to decide how to respond based on the information he or she just received from the acting pupil at that very moment. In their reflections, the participants also placed great value on being able to practice acting as a teacher, responding to pupils, and testing different types of feedback. The willingness to test and experiment with feedback can be attributed to the controlled and scaffolded environment that approximations provide (Grossman et al., 2009). The feeling of security was also particularly expressed regarding the online environment. In contrast to the participants’ prior experiences of approximations, which concerning Howell and Mikeska (2021) can be considered less authentic for in-the-moment feedback, the role-plays offer a chance for enacting feedback practices in addition to investigating feedback practices.

It is essential to acknowledge the potential limitations in objectivity inherent in the presented results, given that the researcher both collected and analysed the data. Additionally, a discussion of the participant count and amount of data is warranted. Future studies may provide valuable insights for more robust conclusions.

This paper shows that online role-play as an approximation of mathematics teaching offers MTE opportunities for pre-service mathematics teachers to practice using different types of formative feedback and to prepare for responding to pupils in the moment. It also underscores the importance of considering specific aspects like a broader context description to the role-plays and providing the online environment with opportunities to use several forms of expression to optimise the effectiveness of online role-playing. The insights gained from this initial study will inform the design and considerations for a follow-up study. Data collection occurred outside of MTE, highlighting contextual limitations but also prompting considerations for further studies. Building upon the results of this paper and the follow-up study, incorporating role-playing in online MTE could serve as a topic for future research.

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