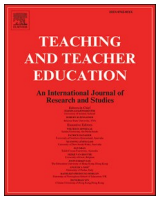
Teaching and Teacher Education 157 (2025) 104949



Contents lists available at ScienceDirect

Teaching and Teacher Education

journal homepage: www.elsevier.com/locate/tate



Research paper

Fostering pre-service teachers' classroom management knowledge, self-efficacy, and professional vision: The effect of different expert feedback and pre-service teachers' feedback perceptions during online video analysis

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ARTICLE INFO

Keywords:
Pre-service teacher education
Feedback
Classroom management
Video analysis
Professional vision
Self-efficacy

ABSTRACT

This study examines how concise (CG) versus elaborate expert feedback (IG) in online video analysis impacts pre-service teachers' knowledge, self-efficacy, and professional vision of classroom management. CG participants showed greater improvement in professional vision than IG participants. Participants' knowledge only improved in the IG. Feedback perceptions fully mediated the association between feedback content and self-efficacy development. Findings suggest that concise and elaborate feedback can differently influence cognitive, meta-cognitive, and motivational outcomes. These results highlight the complexity of feedback content and perception, emphasizing the importance of further research to refine feedback strategies in teacher education.

1. Introduction

A large body of literature shows that classroom management plays a crucial role in teaching with significant impact on students' cognitive, behavioural, and emotional outcomes (Korpershoek et al., 2016; Voss et al., 2011). Numerous studies have shown that incorporating classroom videos into teacher education courses positively affects pre-service teachers' development of professional competence (Gaudin & Chaliès, 2015). Specifically, concerning classroom management, studies have revealed that the use of classroom videos for analysis in teacher education courses significantly enhances pre-service teachers' knowledge (e.g., Piwowar et al., 2013), self-efficacy (e.g., Gold et al., 2017), and professional vision of classroom management (e.g., Weber et al., 2018).

Recent research by Weber et al. (2018) and Prilop et al. (2021) has proven that expert feedback plays a decisive role in augmenting the impact of video analyses on pre-service teachers' competence in classroom management. Across various domains, feedback has been shown to be one of the most significant instructional factors to enhance learning (e.g., Hattie & Timperley, 2007; Narciss, 2013). Studies suggest that especially feedback content can determine feedback efficacy (Panadero & Lipnevich, 2022). So far, teacher education research has examined the effectiveness of feedback at a global level without focusing on content components (e.g., Prilop et al., 2021; Weber et al., 2018). Hence, a gap exists in the literature concerning specific feedback content.

Concerning feedback content, the prevailing assumption in feedback research is that elaborate feedback has a greater impact on feedback recipients than concise feedback (e.g., Narciss, 2008; Shute, 2008; Wu & Schunn, 2020). However, investigations employing systematic (quasi-) experimental designs have yielded mixed findings on the effects of different feedback content. While some studies (e.g., Stark et al., 2011) show that elaborate feedback is more effective, others indicate concise feedback is more beneficial for participants (e.g., Strijbos et al., 2010a, 2010b).

To date, there are no studies in teacher education that investigated the effect of different feedback content on pre-service teachers' professional competence (knowledge, self-efficacy, professional vision). Therefore, our study aimed to determine whether the analysis of classroom videos in an online learning environment supported by elaborate expert feedback promotes pre-service teachers' acquisition of knowledge, self-efficacy, and professional vision of classroom management more compared to concise expert feedback.

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https://doi.org/10.1016/j.tate.2025.104949
Received 11 July 2024; Received in revised form 21 January 2025; Accepted 23 January 2025
Available online 5 February 2025
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2. Theoretical framework

2.1. Teachers' professional competence

For the last 40 years, educational research has studied teacher expertise identifying key characteristics and tracing how it develops (e.g., Berliner, 1988). Based on sociocultural and social cognitive theories of learning, teachers increase their expertise by incorporating knowledge derived from their own experiences of teaching, by observing other teachers' classroom interactions, and by learning from more knowledgeable others into existing cognitive structures (schemata) (Bandura, 1994; Berliner, 1988; Vygotsky, 1978). In comparison to novice teachers, expert teachers' schemata allow for immediate analysis and interpretation of challenging classroom events, for example, concerning classroom management (Peterson & Comeaux, 1987; Wolff et al., 2021). Through a fully integrated network of teaching strategies, experts adapt their classroom behavior to specific classroom events to master the complexities of teaching effectively (Berliner, 2001; Kunter et al., 2013).

Drawing on expertise research, early research into competence defined teachers' professional competence as a combination of professional knowledge and affective-motivational dispositions such as self-efficacy beliefs (Kunter et al., 2013; Shulman, 1987). Blömeke et al. (2015) extended this conceptualization by highlighting that teachers also require situation-specific skills that translate professional knowledge or affective-motivational dispositions into successful classroom performance. These mediating situation-specific skills are also known as professional vision (e.g., Sherin, 2007). They enable teachers to perceive relevant teaching interactions, interpret these, and make decisions concerning further actions (Blömeke et al., 2015). Expert-novice-comparisons show that experts analyze and interpret classroom situations faster and more accurately than novices, hence, possess higher professional vision (Wolff et al., 2015, 2021).

The conceptualizations of expertise and competence indicate that the two concepts are similar but distinctly nuanced. Competence generally refers to the foundational skills, attitudes, and knowledge that enable teachers to perform their duties or teach effectively. Blömeke et al.'s model expands on this by emphasizing situation-specific skills. Expertise, on the other hand, encompasses a deeper and more adaptive understanding and application of these skills, attitudes, and knowledge in varied contexts (van Tartwijk et al., 2023). It represents advanced mastery and the ability to adapt in complex teaching situations, developed through experience and reflective practice (e.g., Depaepe et al., 2020). In other words, while competence forms the baseline ability to teach, expertise reflects a higher level of professional vision.

2.2. Classroom management skills as a part of teachers' professional competence

Research emphasizes classroom management as a prerequisite for successful teaching (Berliner, 2001). This is highlighted by a large body of literature showing that it has a significant impact on students' cognitive, behavioral, and emotional outcomes (Korpershoek et al., 2016; Voss et al., 2011). Classroom management aims to create and maintain learning environments conducive to students' academic and personal development (Brophy, 1999). Gold and Holodynski (2017) defined three key skills concerning classroom management: monitoring, managing momentum, establishing rules and routines. Teachers need to convey to their students that they aware of each students actions at any point in time and that they can handle multiple events simultaneously (monitoring). Furthermore, they need to maintain momentum with their instructional and organizational actions to guarantee a smooth sequence of learning activities. Moreover, teachers need to establish clear and transparent rules and routines to maximize time-on-task.

To manage a classroom effectively, teachers build on different components of their professional competence. Teachers need to use their general pedagogical knowledge (Shulman, 1987) to develop a learning environment that creates and maintains momentum and, thus, a high level of student engagement (Brophy, 2010). However, research shows that effective teaching also requires a high degree of self-efficacy (Zee & Koomen, 2016). Consequently, for successful classroom management, teachers need to believe "in their capabilities to organize and execute the courses of action required to maintain classroom order" (Brouwers & Tomic, 2000, p. 242). After creating an effective learning environment, teachers need to maintain the high level of student engagement and avoid possible disruptions. Hence, teachers require professional vision of classroom management to be able to perceive when disruptions of learning arise or could arise, interpret if actions by the teacher are needed, and then decide on possible strategies (Gold & Holodynski, 2017).

Based on the expert-novice-paradigm (Berliner, 1988), Wolff et al. (2021) propose that novices need to develop classroom management scripts based on often occurring teaching situations (Berliner, 1988; Chi, 2011). For this reason, there has been a call for connecting theory and practice more closely in teacher education by using authentic video cases (Grossman et al., 2009).

2.3. Feedback in the learning process

However, authentic video cases seem to need to be accompanied by feedback. Prominent educational concepts and instructional models highlight the importance of feedback in fostering an individual's competence (e.g., Ericsson et al., 1993; Grossman et al., 2009). Across domains, feedback has been shown to be one of the most significant factors to enhance learning (e.g., Hattie & Timperley, 2007; Wisniewski et al., 2020). Feedback can be defined as a process, in which feedback recipients engage with feedback messages provided by a feedback sender. (Carless & Boud, 2018). From a sociocultural perspective, experts as feedback senders are needed as more knowledgeable others to guide learners into their zone of proximal development (Vygotsky, 1978). Hence, their feedback enables learners to perform tasks that they could not perform without sufficient scaffolding. Apart from the sender and recipient, the feedback message plays a crucial role in the feedback process. Feedback messages consist of information about the feedback recipients' performance and, for example, contain concise evaluative or elaborate tutorial information that can have cognitive, meta-cognitive, or motivational effects (Narciss, 2013). From a social constructivist perspective, students need to construct meaning from the information they are provided with in the feedback messages to improve their work or build learning strategies (Carless & Boud, 2018). Hence, individuals' feedback perception "mediate[s] between the received … feedback and subsequent performance" (Huisman et al., 2018, p. 958). According to Carless and Boud (2018), individuals' feedback literacy, i.e., believing in the value of feedback and managing affective responses toward feedback, determines the degree of feedback uptake.

3. Extant research supporting this study

3.1. Effects of feedback in video-based learning environments on pre-service teachers' professional competence

Authentic teaching cases are increasingly being implemented into teacher education through the analysis of classroom videos (e.g., Sherin, 2007; Weber et al., 2018). Classroom videos can capture the complex classroom reality and allow for repeated analysis of specific situations with changing focus (Sherin & van Es, 2009; Spiro et al., 2007). Numerous studies have shown the positive influence of the use of video cases on the professional competence of teachers and pre-service teachers concerning knowledge, self-efficacy, or professional vision.

Concerning pre-service teachers' knowledge, pre-service teachers analyzed classroom videos concerning classroom management in a study by Hellermann et al. (2015). In comparison to a control group, students of the intervention groups increased their classroom

management knowledge significantly. Although feedback occasions are not concretely outlined, students discussed their analyses with each other and received guidance by the course instructor. Gold et al. (2021) were able to replicate these findings in a subsequent study. In an in-service teacher study (Piwowar et al., 2013), teachers filmed themselves and reflected on their practice in video circles. The video circles were explicitly designed to allow for feedback and co-construction of knowledge. In contrast to a training group that did not conduct video circles, the video circle group reported higher knowledge of classroom management regarding time management.

Regarding pre-service teachers' self-efficacy, Gold et al. (2017) found that the analysis of classroom videos during a course increased pre-service teachers' self-efficacy concerning classroom management in comparison to an untreated control group. Gold et al. concluded that the classroom management videos functioned as vicarious experiences. Vicarious experiences are seen as a central source of self-efficacy (Bandura, 1994). In a practicum setting, Weber et al. (2019) investigated whether analyzing classroom management based on video recordings in a digital feedback environment had more effect on pre-service teachers' self-efficacy than when pre-service teachers' analyzed their teaching from memory in face-to-face feedback sessions. Weber et al. found that the video-based analysis had a significantly higher impact than the memory-based analysis. Weber et al. ascertained that the increase of self-efficacy is based on the combination of video and feedback.

Concerning professional vision, many studies analyzed how video analysis supports the development of pre- and in-service teachers' professional vision (e.g., Barnhart & van Es, 2015; Fadde & Sullivan, 2013). Regarding classroom management, Gold et al. (2013) were able to show that video analysis led to an increase of pre-service teachers' professional vision in comparison to a control group that did not work on the topic of classroom management or with classroom videos. These findings were replicated in a subsequent study (Hellermann et al., 2015). In both studies, pre-service teachers received guidance from the instructor and discussed their video analyses with peers, which can be seen as feedback occasions. However, in a recent study following a similar design, Gold et al. (2021) found that analyzing videos accompanied only by peer discussions did not foster pre-service teachers' professional vision more in comparison to a control group. Gold et al. assume that being able to discuss classroom management with an experienced teacher is necessary to be able to perceive less salient classroom management. The role of expert feedback was more closely analyzed by Weber et al. (2018) and Prilop et al. (2021). Weber et al. (2018) were able to establish that pre-service teachers' professional vision of classroom management was promoted more when they were provided with additional expert feedback, not only peer feedback. In the study by Prilop et al. (2021), pre-service teachers who were provided with expert feedback on their classroom video analyses improved their professional vision in comparison to a non-feedback control group. Prilop et al. (2021) concluded that due to their expertise, experts highlight crucial classroom management events in their feedback, that otherwise go unnoticed by novices.

3.2. Effects of different feedback types

Feedback content can determine the efficacy of feedback (Panadero & Lipnevich, 2022). It can include concise, evaluative or elaborate, tutorial content components (Narciss, 2008), which in turn can relate to the completed task (performance), the ongoing learning process or the self-regulation of the feedback recipient (Hattie & Timperley, 2007). Concise, evaluative feedback provides learners with summative information about the performance (knowledge of performance), confirmation of correct answers (knowledge of result) or correct task solutions (knowledge of correct response). Elaborate, tutorial feedback provides learners with additional information alongside evaluative aspects (Narciss, 2008). These can include explanations of mistakes (knowledge about mistakes), solution strategies (knowledge about how to proceed) or metacognitive strategies (knowledge on meta-cognition). In general, feedback that relates to the learning process or the self-regulation of the feedback recipient is assumed to entail deeper learning, as the learners are enabled to build competencies themselves by checking and regulating their actions and thereby solve future tasks independently (Hattie & Timperley, 2007).

To date, there are no studies in teacher education that investigated the effect of different feedback content on (pre-service) teachers' professional competence. Previous studies in teacher education have examined the effectiveness of feedback at a global level without analyzing the effect of different feedback content (e.g., Prilop et al., 2021; Weber et al., 2018).

Research investigating the effect of different feedback content made mixed findings. Studies examining feedback that contains explanations (e.g., knowledge about mistakes) have shown that the quality of explanations in peer feedback determined student achievement (Gielen et al., 2010) and led to higher motivation among participants (Huisman et al., 2018). In a study comparing the effect of concise knowledge of results feedback and elaborate tutoring feedback, Stark et al. (2011) found that elaborate tutoring feedback fostered participants' conditional knowledge more than concise feedback. Divergent results were found by Lu and Law (2012). Lu and Law found no significant influence of explanations (knowledge about mistakes) or alternatives (knowledge on how to proceed) on student performance. Furthermore, Strijbos et al. (2010a, 2010b) showed that concise knowledge of results feedback compared to a combination of concise and elaborative feedback (knowledge of results, knowledge of mistakes, knowledge on how to proceed) led to better student performance than the combined feedback variant. Strijbos et al. assumed this result may be based on students relying too much on elaborate feedback. Instead of actively engaging with the task again, students may have reacted passively as they received sufficient information in the elaborate feedback. Studies comparing expert with peer feedback may shed some more light on this finding (Gielen et al., 2010). Studies found that feedback that induced a degree of uncertainty (peer feedback) because it did not offer conclusive knowledge by an authority (expert feedback), lead to increased student performance (Yang et al., 2006). Hence, elaborate feedback may be too comprehensive to induce uncertainty, while concise feedback leaves more room for uncertainty and a need for students to construct knowledge for themselves (Bangert-Drowns et al., 1991).

3.3. Feedback perceptions

Research suggests that how feedback is perceived determines the feedback uptake, hence, its efficacy (Ilgen et al., 1979; Strijbos et al., 2021). By reviewing the processes through which feedback influences behavior, Ilgen et al. (1979) concluded that for feedback to be effective it needs to be perceived as useful by the recipient, be accepted by the recipient, and increase recipients' willingness to improve.

Research concerning feedback content shows that elaborate feedback is generally perceived as more adequate and with more willingness to improve. For instance, Straub (1997) investigated student perceptions of teacher comments on a writing task. The study revealed that students "favored detailed commentary with specific and elaborate comments" (p. 91) including advice and explanations. In the same vein, Tsui and Ng (2000) were able to show that only specific and elaborate feedback influenced performance. School students working on a text revision incorporated feedback only if it was perceived as helpful due to its suggestions and explanations. Two recent studies analyzed the effects of different feedback content. Huisman et al. (2018) investigated the perception of peer feedback in an academic writing task. They were able to show that elaborative peer feedback positively correlated with student perceptions of the adequacy of the peer feedback and their willingness to improve. Berndt et al. (2018) analyzed the effect of elaborate specific and concise general feedback content. They established that

elaborate feedback leads to more positive affect than concise feedback. Although the previously mentioned study by Berndt et al. (2018) was based on Strijbos et al.'s (2010a, 2010b) intervention, the latter established partially adverse results. Though elaborate specific feedback was also perceived as more adequate than concise general feedback, it resulted in negative affect – that is, it can debilitate performance.

Findings of studies investigating the relationship between feedback perception and uptake of feedback are mixed. While van Pol et al. (2008) found that students' level of agreement with feedback correlated with the number of revisions made, Strijbos et al. (2010a, 2010b), Kaufman and Schunn (2011), or Huisman et al. (2018) could not find a relation between feedback perception and revision performance or frequency of revisions. Huisman et al. (2018) concluded that students' perception of what can be considered helpful feedback may not be related to their subsequent performance. Based on interviews, Kaufman and Schunn (2011) shed some more light on why students made revisions. They found that students questioned the feedback but reflected more on their own work. However, all these studies focused on peer feedback. To our knowledge, there is a lack of studies investigating associations between perception of expert feedback and students' performance.

4. Research questions

In the current study, we investigated whether analysing classroom videos supported by elaborate expert feedback (intervention group, IG) promoted pre-service teachers' knowledge, self-efficacy, and professional vision of classroom management more than supported by concise expert feedback (control group, CG).

Consequently, the following research questions were investigated:

(1) What impact do concise and elaborate feedback have on pre-service teachers' knowledge, self-efficacy, and professional vision of classroom management and to what extent does elaborate expert feedback enhance pre-service teachers' knowledge, self-efficacy, and professional vision more than concise expert feedback?
(2) To what extent does the perception of expert feedback, concerning the dimensions Perceived Adequacy of Feedback, Willingness to Improve, and Affect, differ between participants in the CG and IG, and how do these dimensions mediate pre-service teachers' change of knowledge, self-efficacy, and professional vision?

Regarding research question 1, it is expected that pre-service teachers improve their knowledge, self-efficacy, and professional vision significantly as numerous studies (e.g., Gold et al., 2017; Piwowar et al., 2013) indicate the positive impact of video analysis on pre-service teachers' competence. Furthermore, expert feedback has been shown to be necessary for the development of pre-service teachers# self-efficacy and professional vision (Prilop et al., 2021; Weber et al., 2019). Moreover, it is presumed that elaborate expert feedback has more impact on pre-service teachers' knowledge, self-efficacy, and professional vision than concise expert feedback. Studies systematically comparing different feedback content have yielded mixed results (e.g., Stark et al., 2011; Strijbos et al., 2010a, 2010b). Yet, most studies suggest that elaborate feedback is more effective (e.g., Gielen et al., 2010; Huisman et al., 2018). Regarding research question 2, studies that analyzed feedback perceptions were able to show that elaborate feedback was perceived more positively (e.g., Berndt et al., 2018; Huisman et al., 2018). Therefore, it is expected that elaborate expert feedback will also be perceived more positively than concise expert feedback. Concerning the impact feedback perceptions have on subsequent performance, we did not formulate a hypothesis due to the mixed results of prior studies (e.g., Strijbos et al., 2010a, 2010b; van Pol et al., 2008).

5. Method

5.1. Intervention design

To answer the research questions, an intervention study was designed in teacher education. More specifically, the intervention was conducted in the course "Analysis, practice and reflection of teaching" which prepares pre-service teachers for their first teaching practicum. The course content was based on a previous intervention study (Prilop et al., 2021) and focused on classroom management and peer feedback (see Fig. 1). The intervention was conducted during the sessions dealing with classroom management. The course was taught twice by the same instructor, so that one of the course groups functioned as intervention group (IG) and one course group as control group (CG).

The course took place during the Covid-19 pandemic so that no face-to-face meetings were possible. Individual course sessions followed a flipped classroom approach, i.e., synchronous course sessions on Zoom alternated with asynchronous course sessions in a digital learning environment. The first course session (week 1) provided the theoretical framework of the course that was based on Blömeke et al.'s (2015) competence as a continuum model and Grossman et al.'s (2009) core practice approach. In the part of the course on classroom management (week 3–10), two core practices of classroom management were focused on: managing transitions (week 3–6) and dealing with classroom disruptions (week 7–10). Synchronous course sessions followed the same structure. Pre-service teachers received theoretical, methodological and empirical input on the core practices for approximately 30 min. Following the input phase, pre-service teachers analyzed a short classroom video sequence in groups for approximately 30 min. The last 30 min of synchronous sessions was used for a discussion of the analyses. In the asynchronous sessions pre-service teachers were provided with tasks for video analysis which they had to upload to a digital learning environment. Following the first analysis, pre-service teachers received feedback on their analyses and were supposed to revise their previous analyses in addition to analyzing another classroom video. Pre-service teachers were free to complete the tasks from the asynchronous sessions at any time prior to the next synchronous course session. The pre- and post-test took place asynchronously in week 2 and week 11.

5.2. Participants

The study participants were pre-service teachers predominantly in their 3rd semester ($M_{Semester} = 3.04$, $SD_{Semester} = 0.60$) at a metropolitan German university. Students taking part in the course "Analysis, practice and reflection of teaching" were invited to participate in the study.

The sample consisted of 59 pre-service teachers. Data from three participants were excluded from the study because they did not complete the tests fully or did not sign consent for data use (CG: n = 1, IG: n = 2). Consequently, 56 pre-service teachers participated in the study, with 30 participants in the control group, 56.7% female; $M_{Age} = 22.10$ years, $SD_{Age} = 2.96$, and 26 participants, 61.5% female; $M_{Age} = 25.30$, $SD_{Age} = 8.35$, in the intervention group. Pre-service teachers did not differ significantly concerning their teaching experience, $t(54) = 0.054$, $p = .48$, $M_{CG} = 1.67$, $SD_{CG} = 0.76$, $M_{IG} = 1.65$, $SD_{IG} = 1.02$, and motivation, $t(54) = 0.735$, $p = .23$, $M_{CG} = 2.88$, $SD_{CG} = 0.39$, $M_{IG} = 2.81$, $SD_{IG} = 0.39$. Scales by Prilop et al. (2021) were used to assess teaching experience and Jerusalem and Klein-Heßling (2007) to assess motivation.

All participants were informed about the study purpose and signed consent. Ethical approval was not required for the study in accordance with guidelines produced by the German Research Association (German Research Association, 2023). Following the Office for Human Research Protections' guidelines (2009), research carried out within a traditional educational environment for the purpose of comparing instructional methods does not necessitate ethical oversight. Nonetheless, quasi-experimental studies raise certain ethical questions, especially

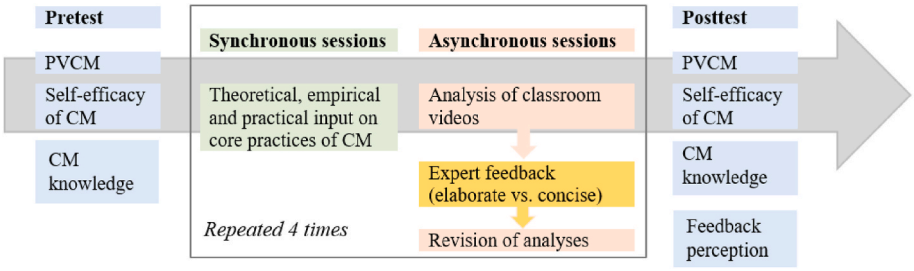


Fig. 1. Overview of the intervention.

concerning pressure to participate. Therefore, pre-service teachers were informed that participation was entirely voluntary and anonymous. Anonymity was ensured through anonymous links provided for the test. To maintain anonymity, a personalized eight-character code, created by the participants themselves, was used to match pre- and post-test results, keeping individual results unknown to the research team.

5.3. Video analysis and feedback process

5.3.1. Classroom videos

Pre-service teachers analyzed nine videos concerning classroom management during the asynchronous online phases. Classroom videos need to be carefully chosen and offer sufficient contextual information to prevent attentional biases or cognitive overload (Syring et al., 2016; Körkkö et al., 2019). Videos filmed in actual classrooms and pre-selected for the domain of classroom management from the ViU video platform (https://www.uni-muenster.de/Koviu/) and the FOCUS video platform (https://tetfolio.fu-berlin.de/web/focus) were chosen for analysis. Video sequences ranged from four to 8 min in length and were supplemented with contextual information (e.g., class, topic teaching sequence). Classroom videos showed successful and less successful classroom management by a variety of teachers.

To support pre-service teachers' analyses, content-related and methodological support was implemented in the OpenOlat-based digital learning environment. Pre-service teachers received specific criteria with examples to guide their analyses (Santagata & Angelici, 2010), reduce their cognitive load, and avoid attentional biases (Derry et al., 2014; Syring et al., 2016). The criteria for analysis of the core practices managing transitions and dealing with classroom disruptions was based on the Manual for Theory-Guided Interpretation of Classroom Management-Relevant Teaching Events (Gippert et al., 2019). Effective transition management, for example, relies on a well-prepared learning environment incorporating established rules and routines and proactive monitoring by the teacher to minimizes disruptions, ensuring a seamless and smooth transition between instructional phases (Weber et al., 2022). Hence, for their analyses, pre-service teachers used criteria, such as withitness, overlapping actions, or established routines, to identify and judge the teachers' transition management. To promote an in-depth and structured analysis, pre-service teachers were supposed to follow a three-step analytical approach (Blomberg et al., 2013; Weber et al., 2018). The three-step analytical approach consisted of, first, describing relevant classroom management events, second, evaluating these and explaining the evaluations, and third, suggesting possible alternative courses of action.

5.3.2. Feedback

Pre-service teachers analyzed individual classroom management sequences during the asynchronous course weeks and uploaded their analyses to the digital learning environment. During the synchronous course weeks, they received expert feedback on their analyses online and revised their analyses in the next asynchronous week. Consequently, pre-service teachers were provided with four expert feedback during the eight-week intervention phase.

Expert feedback was composed following a set of criteria (Prilop & Weber, 2023; Prins et al., 2006). To prevent differences in feedback composition, all feedback followed the same structure (see Fig. 2). In both conditions (CG, IG), pre-service teachers received feedback that was written in first-person, contained a short summative evaluation of the analysis, highlighted positive and sub-optimal elements of the analysis, and included activating questions for reflection.

Feedback for pre-service teachers from the IG additionally contained an elaborate explanation of missed classroom management events in the analysis. Elaborate explanations included a brief description and evaluation of salient events and possible alternative approaches. In the following, an example of the *elaborate explanation of missed events* is presented. It relates back to criteria used for the analysis of transition management (monitoring, continuing classroom dialogue):

> As a suggestion for the revision of your analysis, I would like to focus on one situation as an example. In the sequence from the lesson, it is very clear to see how the teacher aims to enforce the adherence to rules. At the beginning, the teacher reminds the pupils to follow the rules, saying, "Wait a moment … you raise your hand". However, this interrupts the flow of the lesson. In terms of monitoring, a brief, low-key gesture might have been sufficient to remind the students to raise their hands. Thus, there is no overlap of processes. Through brief, low-key gestures, an overlap of "preventing disruptive behavior" and "continuing classroom dialogue" could have been achieved.

All feedback was composed by the same expert,[1] the first author. Writing individual feedback took approx. 15 min for each pre-service teacher of the CG and 20 min for each pre-service teacher of the IG.

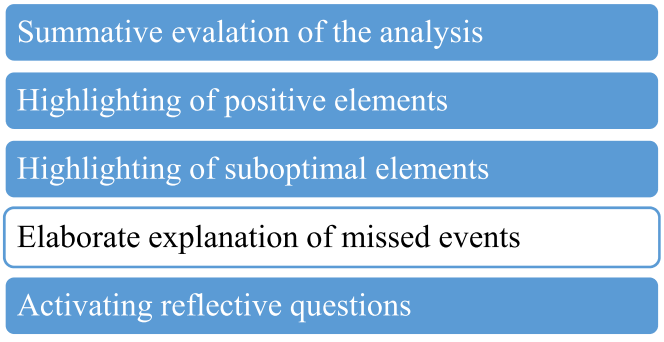


Fig. 2. Structure and elements of concise (CG) and elaborate (IG) expert feedback (elaborate explanation only in IG).

[1] Although the 'expert' has seven years of active teaching experience at schools, did a PhD focusing on classroom management and feedback, and published extensively in this field, expertise is a relative term. Consequently, in this study, 'expert feedback' refers to feedback provided by someone whom students likely perceive as an expert.

5.4. Instruments

5.4.1. Self-efficacy concerning classroom management

During the pre- and posttest pre-service teachers' self-efficacy regarding classroom management was assessed using the German version (Pfitzner-Eden, 2016) of the Teachers Sense of Efficacy Scale (TSES) developed by Tschannen-Moran and Woolfolk Hoy (2001). Only the subscale concerning classroom management was used as the other subscales (instructional strategies, student engagement) of the TSES did not apply to our research focus. The scale consists of 4 items (e.g., *How certain are you that you can control disruptive behavior in the classroom?*). Pre-service teachers were asked to judge their ability to manage challenging classroom situations on a 9-point response scale, ranging from "not at all certain" to "absolutely certain". Internal consistency coefficients (Cronbach's $\alpha_{pretest} = 0.79$, $\alpha_{posttest} = 0.84$) were satisfactory to good.

5.4.2. Classroom management knowledge

To assess pre-service teachers' classroom management knowledge, we used items from the pedagogical teaching knowledge instrument (König & Blömeke, 2010). The three items specifically target the prevention of classroom disturbances and the efficient utilization of instructional time. Pre-service teachers were presented with multiple-choice questions related to classroom management, such as, " What is the best way for you as a teacher to ensure that your students have enough time to study?" (Correct answer: "Planning, teaching, and demanding routine teaching processes"). Responses were scored, with the mean score calculated on a scale from 0 (no correct answers) to 1 (all answers correct). The internal consistency, measured by Cronbach's α, was good at Cronbach's $\alpha_{Pre\text{-}test} = 0.76$, Cronbach's $\alpha_{Post\text{-}test} = 0.81$.

5.4.3. Professional vision of classroom management

Pre-service teachers' professional vision of classroom management (PVCM) was assessed using a standardized video-based online test (Gold & Holodynski, 2017) during the pre- and posttest. In their test, Gold and Holodynski differentiated between the facets of monitoring (12 items), managing momentum (15 items), and rules and routines (14 items). The test uses three classroom video sequences ranging from two to 5 min in length. Participants were presented the individual video sequences accompanied by information on the grade of the class, the topic, learning goals of the unit and lesson and events leading up to the video sequence. The video sequence could only be watched once. Following the information on the video sequence and the video sequence itself, participants were asked to rate items corresponding to the three classroom management facets (monitoring, managing momentum, rules and routines). The items contained either descriptions (e.g., The teacher uses a sign to initiate the transition from individual work to joint work) or interpretations (e.g., Some students could not follow the lesson because the teacher explained it too quickly) of classroom management in the video. The four-point rating scale ranged from 1 – agree to 4 – disagree. Pre-service teachers' ratings were analyzed according to the corresponding content facet (monitoring, managing momentum, rules and routines).

By comparing pre-service teachers' ratings with a master rating based on 15 experts in classroom management, the mean agreement of pre-service teachers with experts' professional vision was calculated. Values range from no agreement – 0 to full agreement – 2. Internal consistency analyses showed satisfactory to good reliability for the individual scales (monitoring: Cronbach's $\alpha_{Pretest} = 0.73$, Cronbach's $\alpha_{Posttest} = 0.79$; managing momentum: Cronbach's $\alpha_{Pretest} = 0.71$, Cronbach's $\alpha_{Posttest} = 0.78$; rules and routines: Cronbach's $\alpha_{Pretest} = 0.52$, Cronbach's $\alpha_{Posttest} = 0.74$), and the overall test (Cronbach's $\alpha_{Pretest} = 0.86$, Cronbach's $\alpha_{Posttest} = 0.90$). The questionable reliability of rules and routines in the pretest develops positively in the posttest, indicating satisfactory reliability.

5.4.4. Perception of feedback

After the intervention, pre-service teachers were asked how they perceived the feedback they had received. The German version of the feedback perceptions questionnaire (Strijbos et al., 2010a, 2010b) was used to measure pre-service teachers' feedback perceptions. The questionnaire consists of three scales: perceived adequacy of feedback, willingness to improve and affect. One item was adapted to the context of this study as the scales were originally developed for a revision task. Consequently, "text revision assignments" was substituted with "analyses". The *perceived adequacy of feedback* scale consisted of nine items (e.g., "*I would consider this feedback fair*"; "*I would accept this feedback*"). It evaluated whether pre-service teachers perceived the feedback as fair and useful as well as whether they accept it. The *willingness to improve* scale measured whether feedback led to new goals and motivation using three items (e.g., "*I am willing to improve my performance*"). The *affect* scale assessed pre-service teachers' affect after receiving feedback with six items (e.g., "*I would feel offended/confident if I received this feedback*"). Negatively phrased items were recoded so that a high value shows positive affect. Pre-service teachers had to judge items on a 10-point bi-polar scale (1 = "fully disagree", 10 = "fully agree"). The internal consistency of the scales was good to excellent (*perceived adequacy of feedback*, Cronbach's α = .94; *willingness to improve*, α = .83; *affect*, α = .86).

5.5. Data analysis

A priori power analyses using the program GPower (Faul et al., 2009) established sufficient statistical power for the planned analyses. The alpha level was set at $p < .05$ for all statistical analyses. Before conducting analyses concerning the hypotheses, *t*-tests for independent samples were conducted to check for pretest differences between the CG and IG. Additionally, bivariate Pearson correlations were calculated for knowledge, self-efficacy, and PVCM to strengthen the transparency of the analysis (see Appendix).

Concerning the hypotheses, first, two-way repeated measures analyses of variance (ANOVA) were run to investigate main effects of time of the intervention and differences in development between the CG and IG. Again, knowledge, self-efficacy, and PVCM were entered as dependent variables. To investigate the effect of conditions (CG, IG), the interaction between condition x time was looked at. A significant interaction would show differences in development of knowledge, self-efficacy, or PVCM. The Shapiro-Wilk test showed a slight violation of normal distribution of data. However, due to the sufficient sample size and robustness of parametric analysis tools against violations of normality (Schmider et al., 2010), we used ANOVA. Homogeneity of variance (Levene's test) was met in the ANOVAs.

Subsequently, *t*-tests for paired samples for each group were conducted to analyze for possible significant pre-post-test changes, not shown in the main effects of the repeated measures ANOVA, with knowledge, self-efficacy, and PVCM (overall, monitoring, managing momentum, rules and routines) entered as dependent variables.

Concerning perception of feedback, first, a one-way analysis of variance (ANOVA) was conducted with perceived adequacy of feedback, willingness to improve, and affect entered as dependent variables and the CG and IG as independent variables to assess differences of feedback perception. Post-hoc tests (Bonferroni) were used for pairwise comparison. Second, mediation analyses were conducted using IBM SPSS PROCESS macro version 4.3.1 (Hayes, 2022; Model 4) with bootstrapping (5,000 samples) to calculate 95% confidence intervals for the indirect effect. The mediation analyses examined whether the relationship between the feedback received by pre-service teachers (CG, IG) and their change scores (knowledge, self-efficacy, professional vision) was mediated by their perception of feedback, in terms of Perceived Adequacy of Feedback, Willingness to Improve, and Affect.

6. Results

6.1. Assessment of pre-service teachers' knowledge, self-efficacy, and professional vision prior to the intervention

We conducted *t*-tests for independent samples because differences between CG and IG prior to the intervention could influence estimated effects. CG and IG did not differ significantly regarding classroom management knowledge at the pretest, $t(54) = 0.625$, $p = .54$. or concerning self-efficacy, $t(54) = 1.966$, $p = .054$. Furthermore, no differences between the conditions were established at the pretest for monitoring, $t(54) = 1.659$, $p = .10$, managing momentum, $t(54) = 1.048$, $p = .30$, rules and routines, $t(54) = 1.469$, $p = .15$, or overall PVCM, $t(54) = 1.599$, $p = .12$.

6.2. Development of pre-service teachers' knowledge, self-efficacy, and professional vision

To assess what impact the CG design and the IG design have on pre-service teachers' knowledge about classroom management, self-efficacy concerning classroom management, and professional vision of classroom management, the main effects of time were analyzed by conducting repeated measures ANOVAs for each dependent variable. Subsequently, the time effect was analyzed for each condition (CG, IG) individually (see Table 1) by applying paired samples *t*-tests.

Concerning knowledge about classroom management, the repeated measures ANOVA showed a medium, significant main effect of time, $F(1,53) = 4.169$, $p = .046$, $\eta_p^2 = 0.07$. The paired samples *t*-test showed that members of the intervention group significantly improved their knowledge with a small effect size, $p = .048$, $d = 0.43$. Members of the control group did not improve their knowledge significantly, $p = .12$. The repeated measures ANOVA did not show any significant main effect of time for self-efficacy, $F(1,53) = 2.134$, $p = .15$, $\eta_p^2 = 0.04$. This was also shown by the *t*-test, IG, $p = .06$, or the CG, $p = .31$. Regarding professional vision of classroom management, the repeated measures ANOVA showed a large, significant main effect of time for overall PVCM, $F(1,53) = 18.969$, $p < .001$, $\eta_p^2 = 0.26$, monitoring, $F(1,53) = 12.608$, $p < .001$, $\eta_p^2 = 0.19$, managing momentum, $F(1,53) = 18.696$, $p < .001$, $\eta_p^2 = 0.26$, and, rules and routines, $F(1,53) = 9.854$, $p = .003$, $\eta_p^2 = 0.15$. *T*-test for individual conditions showed that members of the CG improved their PVCM significantly with medium effect sizes for overall PVCM, $p < .001$, $d = 0.75$, monitoring, $p < .001$, $d = 0.79$, managing momentum, $p < .001$, $d = 0.54$, and rules and routines, $p = .002$, $d = 0.65$. Members of the IG only improved their PVCM significantly with small to medium effect sizes for overall PVCM, $p = .025$, $d = 0.38$, and managing momentum, $p = .006$, $d = 0.56$.

Although the main effect of time in the repeated measures ANOVAs indicates a general improvement of pre-service teachers' knowledge, separate analyses for each condition suggest that elaborate expert feedback is needed for improvement of pre-service teachers' knowledge when analyzing classroom videos. Analyzing classroom videos with concise expert feedback did not lead to significant improvements. However, analyses concerning PVCM yield contrary evidence. Pre-service teachers improved in overall PVCM and in all facets of PVCM when being provided with concise expert feedback. Pre-service teachers that received elaborate expert feedback only improved in overall PVCM and managing momentum.

6.3. Effects of expert feedback on preservice teachers' knowledge, self-efficacy, and professional vision

The effect different expert feedback content has on pre-service teachers' knowledge about classroom management, self-efficacy concerning classroom management and professional vision of classroom management was also assessed by comparing the CG and IG using the two-way repeated measures ANOVAs.

Results for pre-service teachers' knowledge about classroom management indicate that expert feedback content did not have any differential impact on members of the CG and IG. No interaction effect of time *x* condition was found, $F(1,53) = 0.010$, $p = .92$, $\eta_p^2 = 0.00$. For self-efficacy concerning classroom management, the ANOVA also did not show an interaction effect of time x condition, $F(1,53) = 0.420$, $p = .52$, $\eta_p^2 = 0.08$. However, the ANOVA for individual facets of classroom management revealed a medium significant interaction effect of time *x* condition for monitoring, $F(1,53) = 4.249$, $p = .044$, $\eta_p^2 = 0.07$. Pre-service teachers' monitoring increased significantly more for the CG in comparison to the IG. For managing momentum, $F(1,53) = 0.000$, $p = .99$, $\eta_p^2 = 0.00$, rules and routines, $F(1,53) = 1.484$, $p = .23$, $\eta_p^2 = 0.03$, and overall classroom management, $F(1,53) = 2.015$, $p = .16$, $\eta_p^2 = 0.04$, analyses failed to approach statistical significance.

Comparing the effect of elaborate or concise expert feedback conditions showed that pre-service teachers improved their PVCM concerning monitoring more with concise expert feedback (CG) than with elaborate expert feedback (IG).

Table 1
Means (M), standard deviations (SD), change (Δ), and effect size for repeated measures (d) for knowledge, self-efficacy, and professional vision.

	Pretest		Post-test		Δ	*t*	*df*	*p*	*d*
	M	*SD*	*M*	*SD*					
Classroom management knowledge									
CG	0.54	0.25	0.63	0.28	0.09	1.126	29	0.12	0.34
IG	0.59	0.29	0.71	0.26	0.12	1.735	25	**.048**	**0.43**
Self-efficacy concerning classroom management									
CG	6.37	0.99	6.48	1.56	0.11	0.504	29	0.31	0.08
IG	6.91	1.09	7.22	0.90	0.31	1.967	25	0.06	0.31
Professional vision of classroom management (PVCM)									
Overall PVCM									
CG	0.98	0.22	1.20	0.36	0.22	4.148	29	**<.001**	**0.75**
IG	1.09	0.28	1.20	0.30	0.11	2.058	25	**.025**	**0.38**
Monitoring									
CG	0.93	0.30	1.21	0.41	0.27	3.890	29	**<.001**	**0.79**
IG	1.08	0.36	1.15	0.35	0.07	1.097	25	0.14	0.20
Managing momentum									
CG	1.03	0.24	1.20	0.38	0.17	3.516	29	**<.001**	**0.54**
IG	1.11	0.27	1.27	0.30	0.17	2.678	25	**.006**	**0.56**
Rules and routines									
CG	0.98	0.25	1.19	0.39	0.21	3.092	29	**.002**	**0.65**
IG	1.08	0.28	1.17	0.36	0.09	1.368	25	0.09	0.28

Note: CG – control group, n = 30; IG – intervention group, n = 26; knowledge: Min. = 0, Max. = 1; self-efficacy: Min. = 1, Max. = 9; PVCM and PVCM facets: Min. = 0, Max. = 2; significant effects printed in bold.

6.4. Feedback perceptions

Descriptive results of the feedback perceptions questionnaire show that both members of the CG and IG generally perceived feedback positively (see Table 2).

One-way analyses of variance showed that feedback perceptions differed significantly between IG and CG for *Perceived Adequacy of Feedback*, $F(1,54) = 6.260$, $p < .015$, $\eta_p^2 = 0.10$, and *Willingness to Improve*, $F(1,54) = 5.873$, $p < .019$, $\eta_p^2 = 0.10$. Differences of feedback perceptions for *Affect*, $F(1,54) = 1.930$, $p = .17$, $\eta_p^2 = 0.02$, failed to reach significance level.

The analyses show that pre-service teachers perceived elaborate expert feedback (IG) as more adequate and reported more willingness to improve due to elaborate expert feedback in comparison to concise expert feedback (CG).

6.5. Feedback perceptions as a mediator

Mediation analyses were conducted to test whether the effect of the feedback pre-service teachers receive in the respective groups (CG, IG) on the change scores is mediated by their feedback perception. The analyses showed that only *Perceived Adequacy of Feedback* and *Willingness to Improve* fully mediated the association between feedback content (CG, IG) and self-efficacy change score. All other mediation analyses did not reveal any partial or full mediation.

Feedback content significantly predicted *Perceived Adequacy of Feedback*, with the model accounting for 10.39% of the variance, $R^2 = 0.1039$, $F(1,54) = 6.26$, $p = .0154$. Feedback content had a significant positive effect on *Perceived Adequacy of Feedback*, $b = 1.1866$, $t(54) = 2.50$, $p = .0154$, 95% CI [0.2358, 2.1374]. *Perceived Adequacy of Feedback* mediated the association between feedback content and self-efficacy change score. The model explained 28.37% of the variance in self-efficacy change score, $R^2 = 0.2837$, $F(2,53) = 10.49$, $p < .001$. *Perceived Adequacy of Feedback* had a significant positive effect on self-efficacy change score, $b = 0.3193$, $t(53) = 4.52$, $p < .001$, 95% CI [0.1776, 0.4611], while the direct effect of feedback content (CG, IG) on self-efficacy change score was not significant, $b = -0.1927$, $t(53) = -0.74$, $p = .4622$, 95% CI [−0.7146, 0.3292]. The indirect effect of feedback content on self-efficacy change score through *Perceived Adequacy of Feedback* was significant, $b = 0.3789$, BootSE = 0.2122, with a 95% CI [0.0352, 0.8451].

Feedback content significantly predicted *Willingness to Improve*, with the model accounting for 9.81% of the variance, $R^2 = 0.0981$, $F(1,54) = 5.87$, $p = .0188$. Feedback content (CG, IG) had a significant positive effect on *Willingness to Improve*, $b = 1.1897$, $t(54) = 2.42$, $p = .0188$, 95% CI [0.2055, 2.1740]. *Willingness to Improve* mediated the association between feedback content and the self-efficacy change score. The model explained 29.97% of the variance, $R^2 = 0.2997$, $F(2,53) = 11.34$, $p < .001$. *Willingness to Improve* had a significant positive effect on the self-efficacy change score, $b = 0.3173$, $t(53) = 4.70$, $p < .001$, 95% CI [0.1819, 0.4527], while the direct effect of feedback content (CG, IG) on the self-efficacy change score was not significant, $b = -0.1913$, $t(53) = -0.75$, $p = .4590$, 95% CI [−0.7057, 0.3231]. The indirect effect of feedback content on the self-efficacy change score through *Willingness to Improve* was significant, $b = 0.3775$, BootSE = 0.2172, with a 95% CI [0.0373, 0.8682].

The full mediations indicate that pre-service teachers' feedback perceptions play a crucial role in enhancing their self-efficacy, rather than the concise (CG) or elaborate feedback (IG) alone. The higher levels of *Perceived Adequacy of Feedback* and *Willingness to Improve* concerning elaborate feedback (IG) suggest that this kind of feedback is more beneficial for supporting pre-service teachers' self-efficacy of classroom management. The lack of partial or full mediations regarding pre-service teachers' knowledge and professional vision change scores show that pre-service teachers' feedback perception does not have significant impact concerning these variables.

Table 2
Mean and standard deviation for perceived adequacy of feedback (PAF), willingness to improve and affect.

	CG		IG	
	M	*SD*	*M*	*SD*
PAF*	7.63	2.23	8.82	1.00
Willingness to improve*	7.57	2.12	8.76	1.43
Affect	8.06	1.86	8.62	0.99

Note: CG = control group; IG = intervention group; Min. = 1, Max. = 10.
* = Significant difference between CG and IG, $p < .05$.

7. Discussion

The study investigated the impact of concise (CG) versus elaborate (IG) expert feedback on pre-service teachers' knowledge, self-efficacy, and professional vision of classroom management in a digital video-based learning environment. The findings reveal nuanced effects of feedback content on various components of professional competence (knowledge, self-efficacy and, professional vision), indicating practical implications and suggesting future research directions.

Concerning knowledge of classroom management, pre-service teachers profit from additional information in expert feedback (IG). This finding aligns with the consensus of feedback research that elaborative feedback has a stronger knowledge impact than concise feedback (e.g., Berndt et al., 2022; Shute, 2008; Wu & Schunn, 2020). In the same vein, Stark et al. (2011) concluded that elaborate feedback is required to acquire complex knowledge. This is supported by Gielen et al. (2010) who found that the quality of explanations predicted student achievement. Regarding self-efficacy, our findings contradict prior studies (e.g., Gold et al., 2017). Pre-service teachers' self-efficacy did not increase significantly. In comparison to Gold et al.'s study, the stagnation of pre-service teachers' self-efficacy beliefs may be based on the shorter period of video analysis (14 weeks vs. 8 weeks) or the choice of video examples (successful vs. unsuccessful classroom management). These factors may influence video analyses' potential to function as vicarious learning experiences, and, thus, impact pre-service teachers' self-efficacy development (Bandura, 1994; Gold et al., 2017). Future studies should therefore investigate to what extent time or choice of video material impacts pre-service teachers' self-efficacy. Concerning professional vision, the results did not support our hypothesis that elaborate expert feedback (IG) would be more effective than concise expert feedback (CG). Participants in CG showed greater improvements concerning professional vision of monitoring. This result challenges the prevailing consensus that more detailed feedback is always superior. It supports Strijbos et al.'s (2010a, 2010b) assumption that students might rely too much on feedback information. Elaborate expert feedback may have been treated as conclusive knowledge due to the included evaluation of salient events and possible alternative approaches and lead to passive feedback reception. On the contrary, concise expert feedback provided to students did not provide exemplary solutions to the task. Hence, concise expert feedback may have induced uncertainty and prompted more active cognitive engagement of pre-service teachers leading to higher gains in professional vision (Gielen et al., 2010; Strijbos et al., 2010a, 2010b). This is supported by findings from Yang et al. (2006), who observed that less definitive feedback can stimulate learners' critical thinking and problem-solving skills, fostering deeper learning through increased cognitive effort.

. The mediation analyses showed that elaborate expert feedback lead to higher *Perceived Adequacy of Feedback* and more *Willingness to Improve*, which in turn impacted pre-service teachers' self-efficacy of classroom management positively. Feedback perceptions did not mediate the impact of feedback content on pre-service teachers' knowledge or professional vision. This finding aligns with van Pol et al. (2008) who found that pre-service teachers' self-efficacy increase was

positively associated with their feedback perception. An explanation for the difference between self-efficacy, knowledge, and professional vision could be that self-efficacy is an affective-motivational disposition. Hence, feedback that pre-service teachers agree with and want to act upon impacts their self-efficacy beliefs positively but does not influence more cognitively driven processes. In combination with other studies (Huisman et al., 2018; Kaufman & Schunn, 2011; Strijbos et al., 2010a, 2010b), our findings suggest that feedback perceptions are less influential than believed concerning cognitive processes. Yet, this warrants future efforts in fostering pre-service teachers' feedback literacy to increase their engagement with feedback that does not meet their expectations, and in harnessing the joint potential of pre-service teachers' feedback perception and feedback content (Carless & Boud, 2018).

Overall, pre-service teachers' development of classroom management knowledge and professional vision of classroom management suggests that the intervention enabled them to develop schemata and scripts that improve their ability to analyze and interpret classroom management (Peterson & Comeaux, 1987; Wolff et al., 2021). The increase in knowledge indicates that elaborate expert feedback successfully scaffolded pre-service teachers' knowledge acquisition. This supports a central assumption of sociocultural theory, that the social interaction with a more knowledgeable other is necessary for individuals' cognitive development (Vygotsky, 1978). As concise expert feedback did not lead to the same results, it can be assumed that extensive scaffolding is needed to guide pre-service teachers' to their zone of proximal development. The effect of concise expert feedback on professional vision reveals a different outcome that can be explained from a social constructivist perspective. Concise expert feedback required pre-service teachers to construct meaning from the feedback message, which can be presumed to have lead to a more fully integrated network of mental schemata. Hence, professional vision increases can be assumed to stem from a more active engagement with the feedback message (Carless & Boud, 2018). Our findings suggest that elaborate expert feedback can be ascribed a more cognitive effect building knowledge, while concise expert feedback also fostered pre-service teachers' meta-cognitive strategy acquisition enhancing their ability to analyze and interpret classroom management efficiently (Narciss, 2013). The impact on pre-service teachers' self-efficacy can be viewed from a social cognitive perspective. The mediation of feedback content by feedback perceptions supports the social cognitive notion that efficacy beliefs are formed through experiences that individuals interpret as successes or failures (Bandura, 1994). Hence, elaborate feedback, that was perceived more positively, seems to have a stronger motivational effect and led pre-service teachers to feel more competent.

7.1. Future research directions and implications for teacher education

Prominent teacher education models such as the core practice approach (Grossman et al., 2009) emphasize the need for structured opportunities where pre-service teachers can engage with expert feedback to develop their professional competence. Our findings suggests that teacher education programs must carefully consider the type of feedback provided at different stages of teacher development to maximize learning outcomes. Based on the findings, distinct feedback phases with different types of feedback can target various outcomes effectively. For instance, in the initial phase of teacher education, elaborate feedback that includes detailed explanations and suggestions can be prioritized to build foundational knowledge and self-efficacy in classroom management. As pre-service teachers gain more experience, concise feedback may be more beneficial for developing professional vision, as it encourages independent analysis and reflection (Strijbos et al., 2010a, 2010b). At the same time, our study emphasizes that teacher educators need to acquire feedback skills to master the complex task of providing effective feedback. Furthermore, to make high-quality feedback more readily available, peer feedback skills should be fostered during teacher education (Prilop & Weber, 2023).

Furthermore, our study showed that pre-service teachers' feedback perceptions played a crucial role concerning self-efficacy. Hence, to enhance the feedback process, teacher educators could consider specifically fostering pre-service teachers' feedback literacy. Enhancing pre-service teachers' belief in the value of feedback and enabling them to manage their affective response to feedback effectively could increase their feedback uptake (Carless & Boud, 2018). Hence, during the a synchronous feedback phase, teacher educators could model the feedback process of the asynchronous learning phase. This modeling can provide pre-service teachers with a clear understanding of the feedback process, enhancing their ability to engage with feedback independently.

While our study provides insights for potential practical implementations, it also encourages future research to consolidate our findings. Future research should systematically analyze the effects of different feedback content sequences and should explore how and when uncertainty can be induced to promote different components of pre-service teachers' professional competence. Due to mixed results of prior studies concerning the association between feedback perception and pre-service teachers' change scores, we did not formulate a specific hypothesis concerning this research question. Hence, we took an exploratory stance to shed more light on these associations. Consequently, our findings should be interpreted cautiously and be validated by hypothesis-driven studies. Regarding feedback perception as a mediator, we suggest designing studies that focus specifically on participants' feedback literacy, possibly with in-depth qualitative analyses to deepen our understanding of the observed effects. Additionally, incorporating multiple feedback sources, including peer feedback and AI-generated feedback, can enhance the multi-dimensional engagement process that is promoted in this study approach. Peer feedback, as suggested by Gielen et al. (2010) and Prilop et al. (2020), can foster a collaborative learning environment where pre-service teachers learn from each other's experiences. AI-generated feedback offers another promising avenue, providing immediate and personalized feedback throughout a feedback dialogue (Carless, 2006) with an AI-chatbot based on pre-defined criteria by teacher educators (Jacobsen & Weber, 2023). Future studies should explore the combined impact of these diverse feedback sources over multiple cycles to understand their contribution to pre-service teachers' professional growth comprehensively.

7.2. Limitations

Despite its contributions, this study has several limitations that should be addressed in future research. First, the sample size was relatively small, which may limit the generalizability of the findings. Although a small sample size is normal for quasi-experimental studies (e.g., Piwowar et al., 2013), cross-institutional studies are an option to increase sample size and enhance generalizability. Second, the study relied on self-report measures to assess feedback perceptions and self-efficacy. Though both measures have been used extensively in research, self-report measures can be subject to social desirability bias. Yet, we believe this would not impact our results as both IG and CG members may display such bias. Third, the scale used to measure classroom management knowledge only consisted of three items. Though reliabilities were good and the scale has been applied in a variety of studies by other researchers, three items may not capture the full scope of a complex construct such as classroom management knowledge. Therefore, subsequent studies should test more extensive classroom management knowledge scales and our results should be interpreted with caution. Fourth, the study did not explore the long-term effects of different feedback content on the professional competence. Longitudinal studies are necessary to understand how feedback influences the development of classroom management knowledge, self-efficacy and professional vision over time in authentic classroom settings (for example during practicums). Especially concerning self-efficacy, it is unclear to what extent pre-service teachers'

self-efficacy beliefs prior to the intervention stem from teaching experience (mastery experience) or vicarious experiences such as video analysis or their personal experiences of watching teachers during their own school student career (Bandura, 1994; Nespor, 1987).

7.3. Conclusion

This study advances our understanding of how different types of expert feedback influence pre-service teachers' professional competence in classroom management. The findings indicate that feedback content can produce cognitive, meta-cognitive, or motivational effects to varying degrees. To effectively address these diverse outcomes, we recommend that teacher educators incorporate distinct feedback phases with different feedback content. First and foremost, our results highlight that feedback is an effective instructional tool that should be integral to teacher education programs. To maximize its effectiveness, developing feedback skills and feedback literacy among both teacher educators and pre-service teachers is essential, as is exploring the potential of AI-generated feedback as a scalable alternative. Overall, our findings highlight the complexities of feedback content and perception, emphasizing the need for further research to refine feedback strategies in teacher education.

CRediT authorship contribution statement

Christopher Neil Prilop: Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Tijs Rotsaert:** Writing – review & editing, Investigation, Conceptualization. **Ruben Vanderlinde:** Writing – review & editing.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT 4 and 4o for limited sections in order to improve the language and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We would like to thank the pre-service teachers who participated in this study. Furthermore, we would like to express our gratitude to Bernadette Gold and Manfred Holodynski for sharing their professional vision instrument with us.

Appendix

Means (*M*), standard deviations (*SD*) and bivariate Pearson correlations of classroom management knowledge, self-efficacy, professional vision, and facets of classroom management (pre-test).

	M	*SD*	1.	2.	3.	4.	5.	6.
1. Knowledge of CM	0.57	0.27	–					
2. Self-efficacy of CM	6.62	1.06	0.04	–				
3. Professional vision of CM	1.03	0.25	0.11	0.29*	–			
Facets of classroom management								
4. Monitoring	1.00	0.34	0.14	0.30*	0.93**	–		
5. Managing momentum	1.07	0.25	0.18	0.22	0.86**	0.71**	–	
6. Rules & routines	1.02	0.27	−0.04	0.25	0.87**	0.72**	0.61**	–

Note: Knowledge of CM – Min = 0, Max = 1, professional vision (facets) of CM – Min = 0, Max = 2; self-efficacy of CM – Min = 1, Max = 9; n = 56; *$p < .05$, **$p < .001$.

Data availability

The authors do not have permission to share data.

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