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# Resonance-sensitive professional vision. A qualitative study on teachers' noticing practices

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Teacher noticing is widely recognized as an important aspect of teachers' competencies and professional development. Drawing on resonance pedagogy, we propose resonance-sensitive professional vision as a new theoretical concept to analyze teacher noticing practices, aiming to highlight often neglected criteria of instructional quality. Our study investigates patterns of noticing among biology teachers using reflexive thematic analysis on a comprehensive qualitative dataset. Stimulated by a video clip that authentically represents complex classroom interactions, 31 group discussions and nine individual interviews were conducted, involving a total of 115 pre-service and in-service biology teachers. Our analysis indicates that pre-service and in-service teachers often rationalize teaching and learning to the extent that they overlook instructional quality criteria emphasized by resonance pedagogy. Most notably, participants focus on the effective achievement of learning outcomes while neglecting the affective engagement of both students and teachers with the learning material. Additionally, their noticing patterns reveal an implicit conceptualization of teaching and learning as processes that are largely steerable and controllable. This perspective tends to ignore the importance of being open and responsive to students' thoughts and navigating the inherent uncertainty of teaching and learning processes. We hypothesize that adopting a resonance-sensitive professional vision could enhance teachers' job satisfaction, foster professional development, and contribute to a good professional life. In contrast, an over-rationalized vision may lead to frustration and increase the risk of long-term occupational dissatisfaction. Further studies are needed to explore the factors influencing professional vision and its relationship with job satisfaction.

KEYWORDS

**instructional quality, job satisfaction, noticing, professional development, professional vision, resonance pedagogy, resonance theory, teacher noticing**

## 1 Introduction

Teacher noticing has become a prominent focus of discussions about teachers' professional competencies and development (König et al., 2022). It refers to the ability of teachers to notice and interpret significant events in the classroom. Teachers use this ability to observe students' ongoing learning progress and identify potential challenges. Due to the complex and dynamic nature of classroom activities, teachers must constantly classify what is relevant (van Es and Sherin, 2008). This process requires clear criteria for instructional quality.

However, teachers face the challenge of meeting contradictory quality criteria and cannot satisfy all pedagogically legitimate requirements equally (Schön, 1983; Helsper, 1996; Labaree, 2000; Shulman, 2005). Helsper (1996) uses the term antinomy to describe indissoluble tensions between opposing expectations and goals that cannot simultaneously guide teachers' actions in a given situation. The central antinomy in school lies between individual learners' specific

needs and general curriculum requirements. Teachers are caught in a double bind: on the one hand, they are expected to consider the individual characteristics of each learner and to be responsive to their specific capabilities, interests, and needs. This orientation requires flexible and open-ended learning designs that provide room for individual adaptation. On the other hand, curricular-related requirements, such as clear learning outcomes, apply to all students and are typically assessed via standardized exams. Scholars like Helsper (1996) and Labaree (2000) argue that professional teaching involves balancing these conflicting criteria. It is important to note that there are no easy either/or solutions here. Both open-ended educational processes and the achievement of fixed learning outcomes play a crucial role in education policies worldwide.

However, in the past 20 years, education policies have increasingly biased teachers toward learning outcomes and assessments, often neglecting other aspects of instructional quality. For example, Germany has focused on defining educational standards in terms of competencies. Globally, there has been an increase in external evaluations, such as the Program for International Student Assessment (PISA) (Zhao, 2020). Critics argue that this shift results in an overemphasis on outcomes, neglecting the transformative approach to education or *Bildung* (Sjöström and Eilks, 2018), which emphasizes individuality and open-ended processes (Biesta, 2009; Connell, 2009; Labaree, 2014; Rosa, 2019). This article argues that this bias is also evident in research on teacher noticing practices.

In the search for a theoretical framework that shifts attention to otherwise neglected criteria of instructional quality, resonance pedagogy (Beljan, 2019) offers a comprehensive approach. The theoretical foundations of resonance pedagogy stem from resonance theory, a sociological approach developed by the German sociologist Rosa (2019). Rosa (2019) provides a critical theory in the tradition of the Frankfurt School, centered on the concept of resonance and the question of how we relate to the world. It is noteworthy that Rosa's theory quickly received attention not just in sociology but also in fields beyond, particularly in pedagogy and education.[1] The main reason for the theory's broad reception is likely that it not only analyses key characteristics and challenges of late modern society, which are relevant to a wide range of social fields, but also draws normative conclusions outlining ways to move forward.[2]

Resonance theory describes modern society as a social formation that can only reproduce itself in a mode of dynamic stabilization—i.e., through growth, acceleration, and innovation. Culturally, this social formation is driven by the attempt to make the world ever more available, controllable, and accessible. Structurally, this leads to "mute" relationships and forms of "alienation," which Rosa (2019, p. 427) links to the current "psychological crisis," characterized by high prevalence rates in stress, anxiety, burnout, and depression (Rosa, 2019, p. 42). Following this diagnosis of modern society, Rosa (2019, p. 17) calls for a fundamental paradigm shift toward a "good life" based on the concept of resonance.

Drawing on the work of Rosa (2019), resonance has been introduced as a relevant concept in pedagogy (Beljan, 2019). It refers to a specific mode of relationship between students, teachers, and learning materials. As a key feature of instructional quality, resonance shifts the focus from outcomes and assessments to the relational dynamics between teachers, students, and learning materials. Resonance is about affection—how things come to concern students and teachers not only cognitively, but also bodily and emotionally. It is also about responding to and transforming each other—speaking with one's own voice rather than simply echoing what others have said, thus fostering mutual transformation through dynamic interaction. This approach suggests that when students and teachers feel a resonant connection to the material and to each other, their learning and teaching experience becomes more profound and meaningful. In contrast, "mute" relationships and "alienation" arise when teaching is narrowly focused on efficiently achieving and mastering prescribed competencies, while neglecting the quality of the relationships (Rosa, 2019, p. 427).

As far as we can see, resonance pedagogy has not yet been applied in research on teacher noticing. However, this approach promises innovative results for at least two reasons. Firstly, unlike many other pedagogical theories, the concept of resonance is based on a broad sociological analysis of late modern society, including education and school, and offers perspectives on how to meet current key challenges. Resonance pedagogy could enrich the discourse on teacher noticing by shifting the focus to instructional quality criteria that are highly relevant in late modern education but have been largely neglected in this field of research. Specifically, it provides a valuable alternative to traditional instructional quality criteria by shifting the focus from standardized outcomes to the quality of relationships between students, teachers, and learning materials in the classroom. Secondly, resonance pedagogy offers a conceptualization of educational processes that may serve as a convincing heuristic for both theoretical and practical purposes. More concretely, it not only provides researchers with a theoretical framework for the analysis of neglected aspects of teacher noticing but may also sensitize teachers to moments of resonance and alienation in their daily practice.

Focusing on biology lessons, our study explores how teachers' noticing is framed and guided by an understanding of instructional quality shaped by resonance. We adopt a "socio-cultural perspective" on teacher noticing (König et al., 2022, p. 2) and combine Goodwin's (1994) concept of professional vision with resonance pedagogy. By introducing resonance-sensitive professional vision as an analytical tool, we aim to analyze teacher noticing from a new theoretical perspective.

## 2 Theoretical considerations

### 2.1 Research on teacher noticing: effective teaching versus good teaching as instructional quality

Teacher noticing is the ability of teachers to notice and interpret significant classroom events (van Es and Sherin, 2008). To justify the significance of a classroom event, research on teacher noticing

1 For pedagogy and education, see, for example Rosa and Endres (2016), Rosa et al. (2018), Beljan (2019), Beljan and Winkler (2019), Felski (2020), and Frydendal and Thing (2023).

2 Most prominent examples include the ecological crisis, with its life-threatening consequences, as well as the psychological crisis, with constantly increasing prevalence rates for stress, burnout, and depression (Rosa, 2019).

invariably relies on a specific understanding of instructional quality. This understanding can be classified using Berliner's (1987, p. 94) heuristic of "effective teaching" and "good teaching." Previous studies on teacher noticing have focused primarily on effective teaching, which we argue is problematic for both research and teacher education.

Berliner (1987, p. 94) argues that "effective teaching" requires an understanding of learning outcomes, such as student achievement, as these outcomes determine the teacher's effectiveness. Research on teacher noticing uses various frameworks to justify which teaching quality criteria are crucial for achieving these outcomes. A widely used model is the "German framework of Three Basic Dimensions" (Praetorius et al., 2018, p. 407), which is central to international studies such as PISA. This model outlines three key characteristics of an effective lesson: (1) cognitive activation, (2) classroom management, and (3) student support. Research has extensively covered the first two. For example, studies on classroom management examine how teachers' professionalism involves noticing and interpreting how well an effective learning environment is established and maintained (e.g., Steffensky et al., 2015). Several studies have referred to Kounin's (1970) research, which showed that effective classroom management is a systematic process of establishing and maintaining an effective learning environment.

In contrast to "effective teaching," Berliner (1987: 94) argues that "good teaching" refers to normative teacher behavior and involves an understanding of the norms and values that guide teaching practices independent of learning outcomes. Even if these two concepts of instructional quality are not mutually exclusive, effective teaching does not always equate to good teaching, and vice versa (Fenstermacher and Richardson, 2005). For instance, Kounin's (1970) traditional characteristics of classroom management, such as discipline and omnipresence, may conflict with students' interest in self-efficacy. This raises debate as to which criteria are most appropriate. However, the structural bias toward effective teaching leaves many important criteria of instructional quality unexplored. First and foremost, quality criteria related to the concept of *Bildung* (Sjöström and Eilks, 2018; Beljan, 2019), which are crucial in late modern education, have been largely overlooked in research on teacher noticing so far.

## 2.2 Applying resonance pedagogy: good teaching as resonance-sensitive teaching

With its close connection to the concept of *Bildung* (Beljan, 2019), resonance pedagogy offers a comprehensive approach for shifting the focus to otherwise neglected aspects of good teaching. Although Rosa (2019) originally developed the concept of resonance in sociology, he established connections to pedagogy early on, paving the way for its broader adoption by education researchers (Beljan, 2019; Frydendal and Thing, 2023; Felski, 2020). In this paper, we build on this foundation and introduce the concept of resonance-sensitive teaching as a quality criterion of good teaching.

In order to understand precisely what resonance-sensitive teaching means, it is essential to explore the concept of resonance more deeply. Rosa (2019, 2020) defines it as a specific mode of relating to the world. He argues that the quality of our life depends on the quality of our relationships with people, objects, and ideas. Thus, Rosa uses the concept not only as an analytical tool to describe these relationships, but also as a normative criterion for what it means to lead a "good life" (Rosa, 2020, p. 2). In pedagogy, the concept of resonance provides a framework for developing instructional quality features that help define good teaching. We will therefore take a close look at the features that define resonance.

Resonance is characterized by four key features. The first is being affected, which means that the individual is "touched" or moved by someone or something, whether it is another person, an experience, an idea, an activity, a conversation, a piece of art, or a school subject like biology (Rosa, 2020, p. 32). For instance, a biology teacher may introduce a new topic, such as the theory of evolution, with an evocative picture. This picture may spark intrinsic interest in students, engaging them and touching them. It is important to note that affection is not only cognitive but also emotional and physical: we are "touched" when we begin to smile, and in moments of intense affection, we may even have tears in our eyes (Rosa, 2019, pp. 134, 246). These physical reactions foster the development of an intrinsic interest in whatever has affected us.

The second key feature is self-efficacy. Originally developed by the psychologist Bandura (1997), psychological research typically defines self-efficacy in result-oriented terms—as the perceived capability to exert control, implement plans and achieve goals (Rosa, 2019). In contrast, resonance theory offers a response-oriented interpretation, understanding self-efficacy as the capacity to respond actively with our own voice and to "feel connected to the world because we ourselves are able to affect something in it (something, that, in turn, also affects us)" (Rosa, 2020, p. 33). For a resonance-sensitive teacher, what matters is therefore not primarily the learning outcome but rather the experience of interplay and reciprocity that emerges in the teaching and learning process. For example, students may respond to the evocative picture by making their own assumptions and interpretations, which are then picked up by fellow students and discussed in class. Through this process, individuals develop mutually responsive relationships between themselves and the world.

The third feature is the transformation of both the individual and the world. This transformation may be brief, resulting in subtle changes in behavior, thought, or attitude, or it can be long-lasting, forming stable "axes of resonance" (Rosa, 2019, p. 195) that deeply influence one's whole life. Schools potentially play a crucial role in transforming individuals' relationships with the world. For example, a student's initial conception about evolution may be discussed and challenged by learning about the theory of evolution in school, leading to cognitive conflict and transformation. Later, the student may reflect on this new understanding while watching an animal documentary at home, further deepening the transformative experience and forming more stable axes of resonance to biology.

The fourth key feature of resonance is uncontrollability. Resonant experiences cannot be produced or generated by following a manual or method; nor is there a guaranteed way to create them. As Rosa (2020, p. 37) explains, "Resonance is inherently uncontrollable. [–] It is a peculiar characteristic of resonance that it can neither be forced nor prevented with absolute certainty." In the context of a biology lesson, uncontrollability emphasizes that it is impossible to predict or control precisely how students will respond to specific input from the teacher. Instead, resonance relies on the uncontrollable voice of the other. Although resonance cannot be fully controlled, teachers can create conditions that make it more

likely. Rosa (2020, p. 44) refers to this as "semicontrollability," where resonant experiences are neither fully contingent nor fully controllable.

Rosa reframes Marx's concept of alienation to describe a mode of relating to the world that stands in contrast to resonance. In this mode, the world fails to resonate with individuals, fails to speak to them, leaving them emotionally and cognitively untouched. Such a world feels "lifeless, dead, empty" (Rosa, 2019, p. 184). In his diagnosis of late modern society, Rosa (2019) focuses on the psychological crisis marked by an increase in mental diseases and considers burnout or depression as forms of alienation. In the context of a biology lesson, alienation occurs when students lack interest in the subject (affection), lack the belief that they have anything meaningful to contribute to a discussion or presentation (self-efficacy), and fail to see how engaging with biology could lead to personal development (transformation), potentially guiding them into unpredictable yet enriching terrain (semicontrollability). Instead, students' relationship with biology becomes "mute" (Rosa, 2019, p. 427). Alienation, in this sense, represents a form of indifference or, as Jaeggi (2014, p. 1) described it, a "relation of relationlessness." Taken to the extreme, students may not only feel indifferent toward biology but may even experience hostility and repulsion, such as when they become anxious about giving a presentation or fear the embarrassment of saying something wrong.

Resonance-sensitive teachers take into account and incorporate the four key features of resonance—affection, self-efficacy, transformation, and semicontrollability—as instructional quality criteria when planning, teaching, observing, and reflecting on lessons. At the same time, "sensitivity to resonance" also implies "sensitivity to alienation" (Rosa, 2019, p. 186). Thus, resonance-sensitive teachers work to identify and address not only conditions that promote resonance in the classroom but also those that hinder it, showing increased awareness of states of indifference and alienation. In practical terms, this implies that teachers are highly sensitive to students' feelings, quickly notice issues like fear, anxiety, or stress, and actively work to create more favorable conditions for resonance. They aim to establish a pedagogical atmosphere of mutual trust and support, where everyone has the opportunity to listen and answer (Bollnow, 1989; Beljan, 2019; Rosa, 2019). Furthermore, resonance-sensitive teachers strive to be the "first tuning fork" (Rosa, 2019, p. 246), providing specific inputs that not only convey relevant knowledge but also communicate the teacher's authentic passion for the subject through gestures, facial expressions, or humor, thereby stimulating students' intrinsic interest and fascination. At the same time, they act as the "second tuning fork," "capable of responding sensitively to student's needs, moods, and interests" (Rosa, 2019, p. 246). Resonance-sensitive teachers also recognize that schools can establish individual axes of resonance to biology that extend far beyond the classroom, potentially becoming essential parts of a "good life" for those who have undergone an intense process of *Bildung* and developed a resonant relationship with the subject (Rosa, 2019, p. 17). They are further aware that experiences of resonance, whether in biology or in any other field, foster "dispositional resonance" (Rosa, 2019, p. 247). This concept refers to an individual's ability to approach the world, including what is unfamiliar and new, with both intrinsic interest and high expectations of self-efficacy. Simply put, experiences of resonance cultivate a belief that many aspects of the world out there are potentially interesting, exciting, and fascinating. In essence, good teaching is rooted in creating resonant experiences.

## 2.3 Socio-cultural perspective: resonance-sensitive professional vision

Following a socio-cultural perspective on teacher noticing (König et al., 2022), we draw on the concept of professional vision (Goodwin, 1994) and integrate it with resonance pedagogy to introduce the concept of resonance-sensitive professional vision. In this approach, resonance serves as the primary instructional quality feature, allowing us to analyze empirically how teachers' noticing practices are shaped and guided by norms and values of resonance pedagogy (Beljan, 2019).

Since Sherin's research group first applied Goodwin's (1994) concept of professional vision to the teaching profession (e.g., Sherin, 2001), it has been explored with various theoretical frameworks and methodological approaches (see the following reviews: Stahnke et al., 2016; Chan et al., 2021; König et al., 2022; Weston and Amador, 2023; Weyers et al., 2023). However, prior reviews indicate that Goodwin's original conceptualization has had limited uptake within the discourse on the teaching profession. The systematic literature review by König et al. (2022, pp. 1–2) "reveals a dominance of a cognitive-psychological perspective of teacher noticing," focusing on mental processes of individual teachers. Even in studies that claim to follow Goodwin's approach, the conceptualization of professional vision as a social practice and the methodological implications for research are rarely discussed explicitly. An exception is the work of Ozcelik and McDonald (2019).

Building on a theory of social practices (Bourdieu, 1977), Goodwin (1994, p. 606) defines professional vision as "socially organized ways of seeing and understanding events." For example, Goodwin (1994, p. 622) describes how "perspectival frameworks" guide what a police expert witness sees in a videotape and how he judges relevant objects. Crucially, Goodwin's analysis emphasizes how professionals use speech to highlight and code events, thereby reconstructing underlying assumptions and guiding expectations that typically remain implicit. In this study, we adopt the term professional vision (Goodwin, 1994) to outline a socio-cultural perspective on teacher noticing, and we conceptualize teachers' professional vision as the socially organized ways to notice, interpret, and understand significant events in the classroom. In doing so, we aim to contribute to current research by exploring the making of professional vision and its social dimension, which are largely unexplored. To date, little is known about the "socially organized ways of seeing and understanding events "(Goodwin, 1994, p. 606) that teachers use.

Considering teacher noticing as a social practice has two main implications for our empirical study. Firstly, we methodologically describe "socially organized perceptual frameworks" (Goodwin, 1994, p. 616) as *patterns of noticing*, which we analyze using reflexive thematic analysis (Braun and Clarke, 2022, see chapter 3.3). These *patterns of noticing* are rooted in a broader professional context that shapes how schoolteachers notice, think, and act, making them widely shared across the teaching community and therefore particularly relevant for teacher education. Secondly, understanding teacher noticing as a social practice (Reckwitz, 2002) does not leave it hidden as a purely cognitive process occurring behind closed doors in teachers' minds, but instead makes noticing visible and accessible within specific social contexts, where it is enacted, such as during joint video observations and classroom debriefings in the context of practice phases in teacher traineeships or peer teaching situations. The importance of these practices is increasing in university teacher

education, the joint analysis of teaching videos becoming standard. This is reflected in the growing number of research projects on video-based teacher education, the proliferation of video portals, and the steady increase in academic publications in this area (Borko et al., 2008; Gaudin and Chaliès, 2015; Seidel, 2022). Therefore, discussing instruction in social contexts offers a promising approach to studying and professionalizing teacher noticing, particularly in university settings.

While our approach is grounded in Goodwin's (1994) conceptualization of professional vision, it also diverges from Goodwin's original empirical settings, which explored how professionals such as police experts enact professional vision while performing tasks, such as analyzing a videotape. In these contexts, talking about what is seen constitutes professional action itself and is the focus of Goodwin's research. In contrast, most studies on teacher noticing—including our own—aim to better understand how teachers notice and interpret instructional situations during lessons. However, because teachers cannot verbalize their thought processes while actively teaching, such studies typically reconstruct professional vision by analyzing how teachers talk about (video-based) representations of classroom situations. While some research has explored teachers' visual attention during lessons through methods like eye-tracking (e.g., Keskin et al., 2023), we—along with other scholars (van Es and Sherin, 2008; McDonald, 2016; Steinwachs and Martens, 2022, 2023, 2025)—argue that analyzing talking about instructional situations offers deep insight into teachers' professional vision.

As previously outlined, we analyze our data through the lens of resonance-sensitive professional vision. Since resonance in pedagogy emphasizes education as a relational process between students, teacher, and material, resonance-sensitive professional vision is best explained using the didactic triangle model, as adapted by Beljan (2019) and Rosa (2019), to illustrate resonant relationships in the classroom (see Figure 1).

In this model, the three sides of the didactic triangle represent potential relationships or axes of resonance between teacher and students, teacher and material, and students and material. Resonance-sensitive professional vision focuses on the quality of these relationships in terms of resonance as the main instructional quality criteria.

1. Teacher-student relationship: Resonance-sensitive professional vision focuses on how teachers and students reach each other and engage in meaningful interactions. Key considerations include how teachers spark students' interest in the material, engage with students' responses, and promote self-efficacy, and how the teachers themselves are transformed through interactions with students.
2. Teacher-material relationship: Resonance-sensitive professional vision explores how the teacher is affected by the material. A high level of affective engagement with the material is considered crucial because this enables the teacher to serve as a "first tuning fork" (Rosa, 2019, p. 246) for the students, igniting fascination with the subject matter.
3. Student-material relationship: Resonance-sensitive professional vision emphasizes establishing an affective and mutual responsive relationship between students and the material. This approach values students' perspectives on the material as starting points for potential transformation with an uncertain outcome. Given the subjective and semicontrollable nature of learning, resonance-sensitive professional vision promotes a flexible, open, and responsive approach to education.

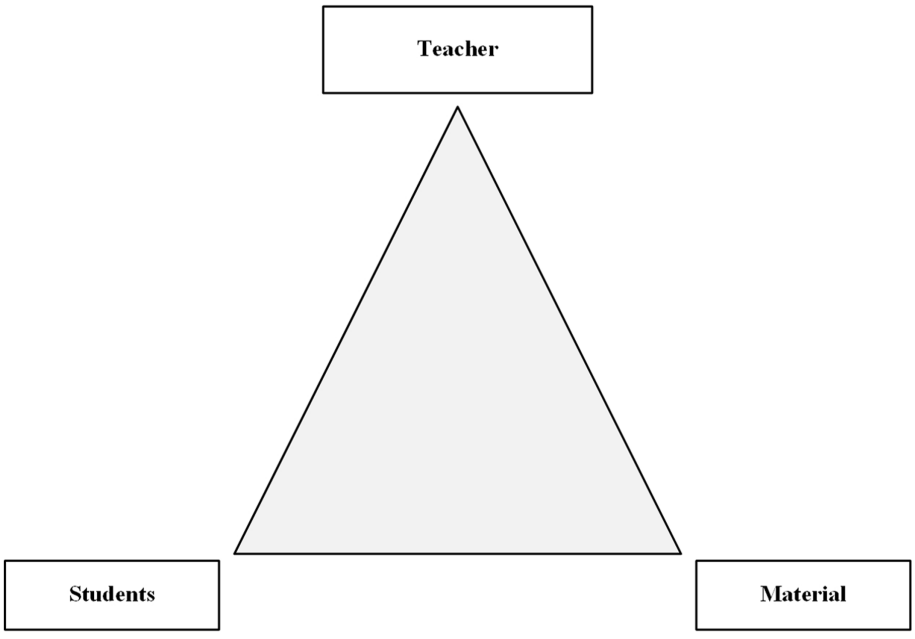


FIGURE 1
The didactic triangle model (Beljan, 2019, p. 113, translated and slightly modified).

TABLE 1 Our sample of 40 cases.

| Professional level | Number of group discussions | Number of individual interviews | Total number of participants | Age | Further information |
|---|---|---|---|---|---|
| Bachelor's and Master's students | 23 | 1 | 79 | 20–35 | Different universities; pursuing different degrees (bachelor's or master's); aiming to teach at various school types (primary, lower secondary, secondary, grammar, comprehensive school, and vocational college) |
| Trainee teachers | 5 | 1 | 18 | 23–30 | Different school types (lower secondary, secondary, grammar, and comprehensive school) |
| In-service teachers | 3 | 7 | 18 | 30–52 | Different school types (primary, lower secondary, secondary, grammar, and comprehensive school); teaching experience ranging from 3 to 29 years |

# 3 Methodical approach

## 3.1 Data collection: video clip as a stimulus for group discussions and individual interviews

For this paper, we conducted a qualitative secondary analysis and used a comprehensive qualitative dataset from a different research project on professional vision (Steinwachs and Martens, 2022, 2023, 2025). Following the methodology of studies such as that by van Es and Sherin (2002), we used a video clip to represent complex classroom settings as authentically as possible. We recorded 51 biology lessons on evolution in secondary schools, each lasting 45 or 60 min, to capture student-teacher interactions. From these recordings, we created a 20-min video clip from an advanced vocational college course that was particularly suitable for joint analysis with pre-service biology teachers, as it provided a rich context for examining teachers' professional vision in a complex educational setting. The focus of the clip is the adaptedness of species to their habitat, addressed in various contexts, such as bird migration.[3]

In line with Goodwin (1994), we chose linguistic data to gain deeper insights into professional vision. The selected video clip served as a stimulus for group discussions (Bohnsack, 2010) and, due to the COVID pandemic, individual interviews (Nohl, 2010). Following Nohl (2017), we assume that group discussions and individual interviews can be triangulated, as both methods allow for the analysis of patterns of noticing. After viewing the video clip, pre-service and in-service biology teachers discussed it without specific instructions or preformulated questions. The openness of data collection is crucial to our research question. Since we are interested in how the professional vision of pre-service and in-service biology teachers is framed and guided by the concept of resonance, it was essential to avoid imposing predetermined frameworks for noticing and interpreting the video clip. The approach aims to provide participants with the maximum freedom to notice, interpret, and address what they find important. We recorded and transcribed both the group discussions and individual interviews to capture the full range of observations and interpretations (Przyborski and Wohlrab-Sahr, 2014, pp. 167–169).

## 3.2 Sample

Our empirical data include 115 pre-service and in-service biology teachers who participated in 31 group discussions (average duration 45 min) and nine individual interviews (average duration 25 min), totaling 40 cases. Each group discussion involved three or four participants, such as colleagues from the same school. Our sampling procedure was a mixture of opportunistic, snowball, and heterogeneous sampling. Pre-service biology teachers were recruited through personal contacts or direct requests to Master's students drafting their theses as part of the research project. Trainee teachers were contacted via the head of the traineeship, while in-service teachers were recruited through the researchers' personal contacts and professional network. In sum, as represented in Table 1, we recruited participants with diverse professional backgrounds, creating a comparatively large qualitative dataset to explore a wide range of teacher noticing practices.

3 An interpretation of the video clip can be found in Steinwachs and Gresch (2019).

## 3.3 Data analysis: reflexive thematic analysis

As mentioned, we reanalyze a dataset which was originally designed for a different project on professional vision (Steinwachs and Martens, 2022, 2023, 2025). A main challenge in qualitative secondary analysis is ensuring the fit of an existing dataset with a new research purpose. In line with recommendations for qualitative secondary analysis (Sherif, 2018; Ruggiano and Perry, 2019), our dataset fits the new research purpose of this paper for three main reasons. Firstly, we focus on the same research area as the parent study, the professional vision of pre-service and in-service teachers. The key difference is our use of resonance pedagogy as a new theoretical perspective to inform our analysis. Secondly, the original methods of data collection—open-ended focus groups and interviews stimulated by a video clip—were not tightly structured but open enough to produce varied and rich data, fitting both the original research interest and our theoretically modified one. Thirdly, the first author of this paper was also involved in the parent study (Steinwachs and Martens, 2022, 2023, 2025) and thus closely familiar with the entire data-gathering process.

We use reflexive thematic analysis (RTA) to reanalyze the data. RTA is a common method for interpreting qualitative data, aiming to "develop an understanding of patterned meaning in relation to the dataset" (Braun and Clarke, 2022, p. 232). Its theoretical flexibility allows us to apply our theoretical thoughts about resonance-sensitive professional vision to inform our interpretation and construct teachers' noticing patterns. Our analysis follows six recursive phases, consistent with RTA guidelines (Braun and Clarke, 2022):

1. Familiarization: The first author, already familiar with the data, re-read transcripts from the perspective of resonance pedagogy, identifying relevant sections. All authors then read these core sections and noted analytic ideas.
2. Coding: All authors independently applied codes to data segments, initially generating over 200 codes. We refined and reduced these to around 50 through collaborative discussions and clustering. Consistent with our deductive orientation—and acknowledging that the underlying assumptions and guiding expectations in teachers' noticing patterns often remain implicit—we focused on deeper latent meanings related to our theoretical framework. Especially in this phase of theory-driven refinement of codes, but also later during the development and refinement of themes (phases four and five), our collaborative approach with intensive group discussions facilitated a richer and more nuanced theoretical exploration of the data.
3. Generating initial themes: All authors independently combined multiple codes that share a core idea, thus identifying shared patterns of meaning across the dataset (i.e., themes).
4. Reviewing themes: We discussed our individually generated themes in a group and collaboratively developed them further in relation to our research question on resonance-sensitive professional vision. Most importantly, we ensured that our themes captured patterns of noticing which are meaningful across the whole dataset. Furthermore, we compared these patterns and began to cluster them around five potential categories derived from the didactic triangle: teacher, students, material, teaching, and learning. We started to reflect on the patterns' relationships and constantly assessed their fit in relation to the coded segments. In addition, the first author checked that the patterns made sense against the background of the full dataset.
5. Defining and naming themes: We refined themes to ensure clear boundaries and reflected on how our patterns connect to each other, resulting in five patterns of noticing connected by an overarching pattern.
6. Writing up: Finally, we developed an analytic narrative to present our results.

To illustrate our interpretations, we present excerpts from selected cases in our sample. For anonymity, all cases were labeled with fruit names (e.g., Mango) that reveal nothing about the content. All interpretations are based on the German transcripts, which were then translated into English. Przyborski and Wohlrab-Sahr (2014) note that translation can create ambiguities and questions about connotations, which can only be resolved by referring to the original German transcripts. Consequently, the original wording cannot be exactly reproduced. To improve readability and comprehension, we used slightly different transcription rules for presenting transcript excerpts.[4]

# 4 Analysis and discussion: patterns of teacher noticing

We reconstructed five patterns of noticing (see Figure 2), anchored together by an overarching pattern that forms an "overall story" about the data (Braun and Clarke, 2006, p. 87). These patterns facilitate an understanding of the extent to which resonance matters in teachers' professional vision.

## 4.1 Pattern of noticing 1: teacher as optimizer of students' learning

Participants' professional vision is guided and framed by certain norms and ideals through which they evaluate what they see. They observe teaching and assess its effectiveness in relation to desired learning outcomes. Participants assume that the main task of the teacher is to optimize students' learning so they can achieve the scientific norms. Therefore, participants constantly compare what the teacher actually has done with what the teacher should have done.

4 Transcription rules, according to Przyborski and Wohlrab-Sahr (2014): all participants are assigned a letter for anonymization. Depending on gender, an "f" (for female) or an "m" (for male) is added to this letter. Word is emphasized. °Word° is said quietly. (3) is a pause of 3 s. ⌊is an overlap of two speakers. @ Word@ is said laughing. Transcription rules according to Dresing and Pehl (2018, pp. 21–24): Word blends are approximated to written German. Stuttering is smoothed or omitted. Word duplications are recorded only if they are used as a stylistic device for emphasis. Half-sentences that lack completion are marked with the break-off character "/." Punctuation is smoothed in favor of readability. If direct speech is quoted in the recording, the quotation is placed in quotation marks.

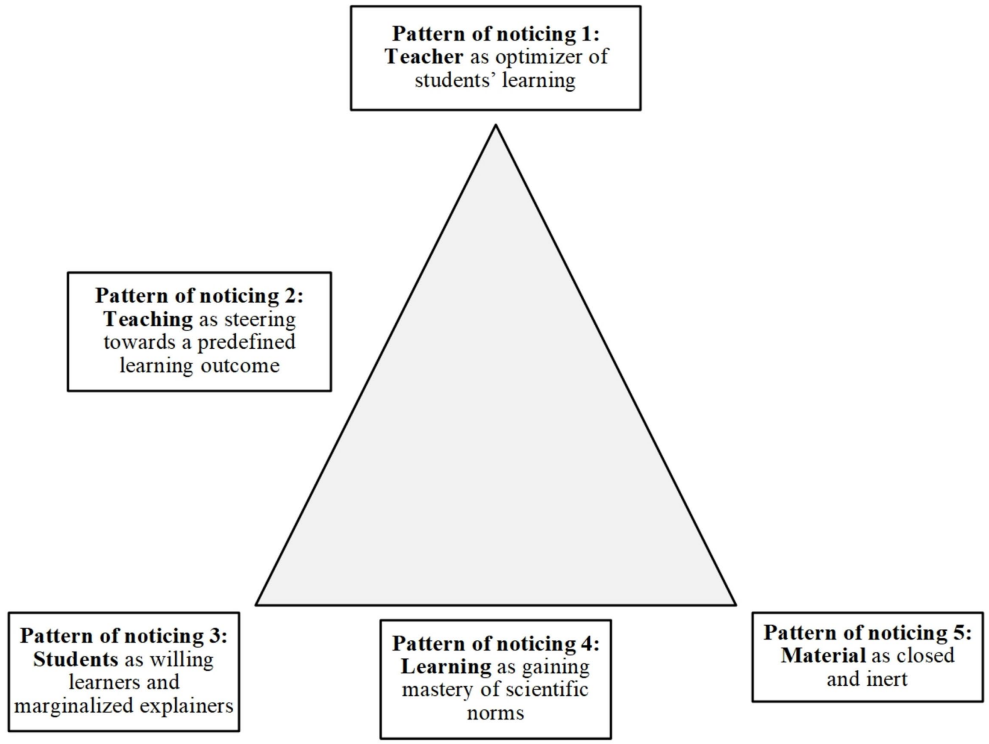


FIGURE 2
Overview of the five patterns of noticing.

Interestingly, the participants' optimization perspective goes hand in hand with a deficit orientation. The level of teaching observed is mainly discussed as deficient and requiring optimization. However, participants hold different opinions about how to concretely optimize teaching. In some cases, like the Mango case, methodical changes are suggested (Excerpt 1). Classroom discussions are critiqued as resembling "a ping-pong game," where "it always just went from the teacher to the student and back again."

Furthermore, the teacher is required to facilitate discussion by "passing the ball" and letting the students "talk among themselves." In other cases, like the Rosehip case, participants criticize the teacher for content-related shortcomings (Excerpt 2), such as the way certain concepts ("selection" and "mutation") are used to explain evolution.

In the case of Rosehip, the way certain concepts such as "selection" and "mutation" are used to explain evolution is criticized. In addition, a "step-by-step approach" is demanded, where these concepts should be applied to the evolutionary phenomenon sequentially and in a specific order.

Resonance pedagogy critically challenges participants' vision of teachers as optimizers of students' learning. Firstly, participants constantly compare what the teacher has actually done with what the teacher should have done to help students achieve the scientific norms. This leads to a one-sided focus on the teacher's shortcomings. The teacher is frequently the subject of criticism, and participants rarely discuss what the teacher has done well or what can be learned from positive examples. One important consequence of participants' deficit orientation is that actions and factors that facilitate resonance are hardly noticed and discussed. For example, students' broad participation and lively discussions are hardly acknowledged. Participants appear to lack any appreciation of the fact that the teacher in the video clip managed to create a "pedagogical atmosphere" (Bollnow, 1989, p. 5) that encouraged students to contribute with their own thoughts and explanations in relation to biological phenomena. However, creating such an atmosphere is not trivial at all and should not be taken for granted. Instead, it should be acknowledged, further explored, and discussed to learn from positive examples about conditions that facilitate resonance in the classroom. Secondly, this pattern places a one-sided focus on what the students can learn from the teacher without considering what the teacher can learn from the students. This can result in loss of sight of resonance, as moments of resonance are inherently reciprocal and characterized by a mutual transformation of the students and the teacher alike. More concretely, resonance happens when the students and the teacher listen to, answer, affect, and transform each other. However, due to a narrow focus on students' learning, participants interpret the teaching-learning process as unilateral: teachers are expected to shape students' understanding, but not the other way around. The teacher is discussed exclusively as an instructor and never as a learner whose pedagogical and content-related knowledge or beliefs may be transformed along with the students.

## 4.2 Pattern of noticing 2: teaching as steering toward a predefined learning outcome

Participants at all levels of training and experience, ranging from early Bachelor's students to experienced teachers, share a strong

Bf: I also think what you just said about partner work is a really good idea, because overall, it often feels like a ping-pong game. It always just went from the ⌊teacher⌋ to the student and back

Af: ⌊Mhm⌋

Bf: again. Especially with topics like this, where discussion is possible, I believe it's much more valuable to ⌊let students talk⌋ among themselves ⌊(.)⌋ by passing the ball, rather than relying

Df: ⌊Mhm⌋ | ⌊Mhm⌋

Bf: solely on this teacher-student exchange.

EXCERPT 1
Excerpt Mango case (l. 430–437).

Af: I thought that the teacher should only give one example so precisely that the correct technical terms are used. Maybe that could have been written down somehow. I think that would have helped everyone. Because in this way, things were repeated again and again that had actually already been said before that they were not like that. Then the teacher gave another example, and the wrong things were said again. Then she gave another example. I had the impression that this/ I would have preferred to say come on, do one of the examples and then you go through it using a step-by-step approach and say selection, mutation of DNA and so on. That you somehow get these passive formulations into it.

EXCERPT 2
Excerpt Rosehip case (l. 36–44).

belief in their ability to optimize teaching and learning. They assume a causal relationship between the level of steering and the efficiency of learning in terms of achieving the learning outcomes. The dominant assumption is that a specific input will produce a specific learning outcome if the process is steered well enough.[5] However, participants interpret the effect of teaching on learning in diverse ways. In some cases, like the Rosehip case, they believe that teachers need to provide strong direction and maintain control over learning (Excerpt 3). The teacher is criticized for failing to prevent students from employing their intuitive explanations of the adaptedness of species to their habitat.

This involves a technological idea of teaching, where the teacher could metaphorically "switch off Lamarck's ideas in everyone" and directly transmit knowledge using "a super clear example where you cannot go wrong." In other cases, like the Mango case, participants criticize the learning opportunities provided by the teacher (Excerpt 4). For example, the use of certain technical terms in the classroom discussion is questioned.

It is suggested that the concept of "adaptedness" should be used instead of "adaptation," as the latter could potentially lead to a "wrong student conception." Essentially, participants assume that appropriate learning opportunities provided by the teacher can significantly influence students' learning to meet the required scientific norms.

In contrast to the participants' dominant vision that learning is largely steerable, resonance pedagogy critically challenges this perspective by acknowledging a "technology deficit of education" (Luhmann and Schorr, 1979, p. 345): teaching-learning processes are complex and do not function in mechanistic ways. In practical terms, teachers cannot fully predict, plan, and control what will happen in students' minds when providing specific input. Therefore, the outcome of a lesson is never entirely certain in advance (Schön, 1983; Biesta, 2023). This is especially true for creating resonance in the classroom, which is at best "semicontrollable" (Rosa, 2020, p. 67). Consequently, teachers who are sensitive to the concept of resonance are aware that it is never completely certain if, how, and when students and teachers will affect, answer to, and transform each other. However, they can recognize and evaluate conditions that might foster resonance in the classroom. One key aspect to observe is how the teacher acts as the "first tuning fork," serving as a source of inspiration and momentum to initiate resonance in the classroom (Beljan, 2019; Rosa, 2019, p. 246). The fact that most participants are convinced of their ability to influence students points to a high level of self-efficacy expectation which, in turn, could be conducive to creating resonant conditions in the classroom.

Nevertheless, from the perspective of resonance pedagogy, participants' steering vision is inherently problematic for at least three reasons. Firstly, it raises unrealistic expectations regarding the steerability and controllability of teaching and learning, thus reinforcing the deficit-oriented vision discussed in connection with participants' optimization perspective (see previous chapter). Secondly, participants with a strong steering vision tend to view unexpected and unplanned events more as problems and burdens to avoid rather than opportunities to embrace resonance. For example, in some cases, students' unexpected explanations are constructed as a

5 In fact, only one teacher in our sample put strong emphasis on the contingent nature of teaching and learning (Maracuja case; see Steinwachs and Martens, 2025). In his view, even the most sophisticated, well planned, and consistently steered teaching effort might miss the expected learning outcomes.

Af: The teacher herself always says that Lamarck's ideas are so deeply rooted in us. It comes through again and again. I think that through these three examples she somehow fails to switch off Lamarck's ideas in everyone.

[…]

Bm: Let me put it this way, with the white gorilla one could at least/ ⌞(3) It is clear to everyone that he is probably not consciously turning white.⌟

Af: ⌞Yes, or you take/ (2) Nope exactly.⌟ But there it came again/ Again, someone said it is in the skin cells and I was like, 'huh'? The white is now in the skin cells? Did he put that in there? That is what it sounded like. So one of them said something like, 'the white goes into the skin cells' or something like that. In any case, very strange. I think why not take a super clear example where you cannot go wrong, like the one with the butterfly that then in industrialization/ ⌞The⌟ trees turn black, the butterfly turns ⌞black⌟. Exactly, that is what it is

Cf: ⌞Yes yes.⌟

Bm: ⌞Industrial melanism.⌟

Af: called. Why not take an example like that, you really cannot do much ⌞wrong⌟.

Cf: ⌞Yes.⌟

EXCERPT 3
Excerpt Rosehip case (l. 65–68; l. 360–371):

Af: There is the distinction between adaptedness ⌞and⌟ adaptation. I think that she doesn't

Df: ⌞Mhm.⌟

Af: differentiate there either. It might be ⌞better⌟ to look and simply talk about the adaptedness.

Df: ⌞Mhm⌟

Af: Because if you say adaptation, then that is like (.) 'I am actively adapting'. Through this language, you are always resonating with (.) a wrong student conception somehow. I think that it would be better if she paid attention to that and only say adaptedness.

Bf: That would also be something else. Because adaptedness is not frequently used in everyday language. ⌞That⌟ would be another demarcation that would be easier for the students.

Df: ⌞Yes.⌟ Just like a new term, ⌞that is introduced.⌟ Yes.

Bf: ⌞Right.⌟

Af: Yes, that would be quite good.

EXCERPT 4
Excerpt Mango case (l. 549–561).

"disturbing factor" that the teacher should "clear […] out first" so that the scientific norms can be taught (Pineapple case, l. 302–303). Nevertheless, it may be precisely during such spontaneously arising moments, when students present unexpected ideas, that experiences of resonance occur that are meaningful for the students. One of the objectives of resonance-sensitive professional vision is to notice and capitalize on such opportunities. Thirdly, resonance pedagogy sheds a critical light on participants' vision that the achievement of predefined learning outcomes is the primary criterion for evaluating instructional quality. Instead, educational processes are more important than learning outcomes. First and foremost, the quality of students' relationship with the learning material is crucial for resonance-sensitive teachers. Questions like are the students "touched" (Rosa, 2019, pp. 134, 246; Rosa, 2020, p. 32) by the material (affection), do they answer with their own voice (self-efficacy), and is there any change in how they relate to and understand the material (transformation) inform a resonance-sensitive professional vision. Despite resonance being (only) "semicontrollable" (Rosa, 2020, p. 67), teachers' awareness of suitable conditions for affection, self-efficacy, and transformation in the classroom is crucial from the perspective of resonance pedagogy.

## 4.3 Pattern of noticing 3: students as willing learners and marginalized explainers

There are more factors that systematically prevent participants from engaging more deeply with students' own concepts and explanations. Most importantly, our data show that teachers constantly

evaluate students' statements by comparing them with scientific norms. In many cases, like the Raspberry case, students' statements are classified as wrong in relation to the right scientific norms (Excerpt 5).

Participants classify students' statements as "misconceptions" that need to be corrected. In some cases, like the Mirabelle case, participants establish a hierarchy where scientific norms are considered more valuable than students' conceptions (Excerpt 6).

These conceptions are constructed as "everyday understanding" and "everyday language" that need to be changed toward scientific norms. Overall, we observe an ongoing marginalization of students' explanations, with the aim of transcending them.

Resonance pedagogy critically challenges participants' vision of students as marginalized explainers. In our sample, students' explanations are never valued as an enrichment or resource for transforming their relationship with nature and making biological knowledge personally meaningful. It is precisely such an appreciative view, combined with the ability to listen closely to students, that enables teachers to adapt their teaching in a way that integrates and builds on students' interests and views, thereby making biological knowledge personally meaningful. In contrast, the marginalization and neglect of students' previous understanding runs the risk of overlooking students' concerns and level of understanding, potentially evoking feelings of alienation with respect to biological phenomena. Moreover, participants' vision of students as marginalized explainers' conflicts with newer learning theories, particularly a constructivist understanding of learning that asserts that "learning is interactive, building on what the student already knows" (Bada, 2015, p. 68). Therefore, teachers should welcome, appreciate, and interpret students' understanding rather than marginalize it.

Resonance theory's emphasis on self-efficacy aligns with this constructivist view on learning: students' voices are important and should be closely considered. They offer valuable insights into students' life worlds and what they find meaningful. A close look at students' concepts informs the teacher about what they bring to the learning and how they understand the material. Considering the crucial role of students' previous understanding and self-efficacy, resonance-sensitive teachers provide space to negotiate multiple perspectives and promote the exchange and discussion of ideas both with and among students. This approach allows students to shape their personal relationship to the learning material, raise their own voices, and reach others. However, such experiences of self-efficacy are unlikely to be noticed if the focus remains rigidly on distinguishing between correct and incorrect responses and on efficiently achieving predefined learning outcomes.

Furthermore, for students to speak with their own voice (Rosa, 2019, pp. 167, 244), a specific "pedagogical atmosphere" is required (Bollnow, 1989, p. 5; Beljan, 2019, p. 90; Rosa, 2019, p. 245). First and foremost, teacher and students must relate to each other in a warm, safe, and appreciative environment where differing views are welcomed. Such an atmosphere allows students to explore and experiment with content and ideas without the fear of embarrassment or losing face when making a mistake. Therefore, resonance-sensitive teachers understand the importance of creating a pedagogical atmosphere that facilitates students' self-efficacy, where mistakes are valued as opportunities for resonance. However, our data shows that participants view students not only as marginalized explainers but also as willing learners. On the one hand, this perspective reflects a positive belief in students. On the other hand, it should include valuing their contributions. Furthermore, from a resonance-sensitive perspective, it is crucial to recognize that students' willingness to learn is also a result of the quality of their relationship with the teacher and the material. It would be wrong to assume that this willingness emerges solely from the students' individual characteristics (Beljan, 2019).

## 4.4 Pattern of noticing 4: learning as gaining mastery of scientific norms

Participants construct learning as gaining mastery of scientific norms, evaluating it by comparing students' statements with these norms. Learning is consistently output-oriented and instrumental, serving as a means to achieve a specific goal—the correct application of scientific norms, such as general evolutionary principles, to biological phenomena. However, participants focus on various aspects of these scientific norms. In some cases, like the Rosehip case, they criticize students for not using central concepts of the theory of evolution (Excerpt 7). For example, they criticize students for failing to follow a "clear structure" using the "right technical terms" in their explanations of evolution, such as "mutation" and "recombination".

The concrete evolutionary biological phenomena themselves are framed as unimportant for the learning process ("these digging hands or whatever," "the white gorilla blah"), it is about teaching certain general concepts of the theory of evolution. Please use period instead of colon. Please do not place a paragraph here. Please revise the marked sentences as follows: In other cases, like the Peach case, participants emphasize the need for clear definitions of evolutionary biology terms (Excerpt 8). The teacher interviewed considers it essential that technical terms like "gene," "allele," and "gene pool" have

Cm: I actually only wrote down three big things. One is that it becomes very clear how many misconceptions the students have and what those misconceptions are. Another is that they use Darwin and Lamarck to enlighten themselves and discuss adaptation. It is said that this should actually be clarified. They watched a film about Darwin and Lamarck and pointed out the differences. They talked about adaptation, and then the students come to the next lesson and start again, ⌊repeating⌋ exactly the same misconceptions. The mole does this because it

Af: ⌊Mhm⌋

Cm: needs big hands, and so on.

EXCERPT 5
Excerpt Raspberry case (l. 190–198).

Af: I thought that she tried to somehow evoke an understanding in the students ⌊that⌋ goes
Df: ⌊Mhm.⌋
Af: beyond this everyday understanding and to evoke this biological/ this evolutionary history. And at that point she also tried ⌊to⌋ activate the students' conceptions a little bit, first of all asking
Cf: ⌊Mhm⌋
Af: ⌊'where⌋ do you know this term from?'What/ a bit of everyday language was ⌊dragged⌋ in
Df: ⌊Mhm⌋
Cf: ⌊Mhm⌋
Af: and then she tried to abstract/ or move away from that to the biological term.

EXCERPT 6
Excerpt Mirabelle case (l. 20–30).

Af: I really think that you should actually take an example and play through it like I said and then classify all these terms. So you could ⌊take⌋ the mole for example and say: what about the
Bm: ⌊Mhm⌋
Af: evolution of the mole, and these digging hands or whatever, these shovels for digging? And then you could play through that, and then you could insert all these aspects, that not only mutation but also recombination plays a role for the descendants and so on. Or you could have played through the white gorilla blah, with the white and black gorilla and which one survives. They always hinted at it in a way, but I always missed the right technical terms and a clear structure every time you go through it.

EXCERPT 7
Excerpt Rosehip case (l. 163–172).

Am: Some students find genetics relatively difficult to learn but are good in ecology - or vice versa. They often struggle to connect these topics within an evolutionary framework, especially since evolution can feel distant in terms of time. Therefore, I always offer review sessions in genetics, for example, where we go over family trees again, revisit the genetic level, clarify concepts such as what a gene is, what an allele is, and so on. We also cover the idea of a gene pool, which is, of course, essential at that point. It's important that students have a clear understanding of these fundamentals in order to construct technically correct arguing within the topic of evolution.

EXCERPT 8
Excerpt Peach case (l. 162–169).

to be learned in order to facilitate "technically correct arguing" in the context of evolution.

Concrete biological phenomena are often of secondary importance in the learning process. This is evidenced by the fact that they are rarely discussed in terms of their inherent potential for fascination. Furthermore, participants sometimes assume that the phenomena are interchangeable, as the focus is on the scientific norms rather than the phenomena themselves.

Resonance pedagogy critically challenges participants' vision of learning as gaining mastery of scientific norms. In contrast to this dominant perspective, resonance-sensitive teachers focus less on the learning outcomes and more on the process, particularly on how students relate to the learning material. The most important question is: were students affected by the material? From the perspective of resonance theory, learning is not solely about cognition but also about affection. Without affection, it is difficult to imagine that students will ever develop individual axes of resonance to biology that are stable and extend beyond the classroom, enabling them to be responsive to biological phenomena in their daily lives. These axes of resonance facilitate students' continual engagement and joy in learning. Therefore, resonance-sensitive teachers adopt a "phenomenological orientation" (Schratz et al., 2013, p. 60) toward what occurs in the classroom. They focus on students' learning experiences and constantly question whether the learning material presented speaks to and affects the students. Questions like do the students show authentic interest and curiosity and do they find it

pleasurable, exciting, and inspiring to engage with the material are crucial for resonance-sensitive teachers. Their aim is to establish a vibrant relationship between students and the learning material (Rosa, 2019). In contrast, the relationship remains mute if students experience learning as an external imposition that says nothing to them, thereby failing to stimulate interest, excitement, and meaningful thoughts (Rosa, 2020). However, questions concerning learning experiences and the development of an affective relationship between students and the material are rarely addressed in our participants' discussions. Instead, their focus is primarily on learning outcomes, specifically the extent to which students gain mastery of scientific norms. Participants' focus on the cognitive aspects of teaching and learning not only leads to a neglect of students' affective relationship with the learning material but also overlooks the teacher's own affection. Is the teacher inspired, excited, fascinated, and "touched" (Rosa, 2019, pp. 134, 246; Rosa, 2020, p. 32) by the material? Is the teacher engaged in an affective relationship with the material, and does it speak to them in ways that transcend pure rational planning, mastery, and control (Rosa, 2019)? We suggest that only teachers who are genuinely affected by biological phenomena and the theory of evolution can effectively share their excitement with students (Beljan, 2019). However, our data show that teachers' level of affection hardly plays a role when they observe and discuss teaching.

## 4.5 Pattern of noticing 5: material as closed and inert

The fifth pattern of noticing concerns participants' vision of the learning material as closed and inert. Closed refers to the idea that participants construct the material as something external to and independent of the students' minds, while inert refers to its conceptualization as stable, fixed, and final. From a basic ontological and epistemological perspective, this vision is rooted in objectivism and realism: participants view biological reality as externally given and objectively accessible. Consequently, stable biological explanations can be found and conceptualized as fixed scientific norms. Any individual explanation of the evolutionary phenomena can be categorized as either right/appropriate or wrong/inappropriate. Teachers aim to teach students how to explain and apply scientific norms correctly. For example, participants evaluate the extent to which general concepts from the theory of evolution, such as the adaptation of species to their habitat, are adequately utilized by the students. Students reach the learning goals when they can explain these concepts and apply them to different biological phenomena such as bird migration.

In contrast to the participants' dominant vision of the learning material and scientific norms as closed, resonance-sensitive teachers view them as open, multifaceted, and responding to students in subjective ways. First and foremost, they carefully observe whether the learning material truly speaks to students, facilitating meaningful connections to their life worlds. Furthermore, unlike participants who see the learning material and scientific norms as inert, resonance-sensitive teachers view them as provisional and dynamic (Rosa, 2019). Science, after all, flourishes within an "epistemic culture" (Knorr Cetina, 1999, p. 3) where established truths are critically questioned and new perspectives are explored. The same is true for learning: it is crucial to foster in students an understanding that learning achievements are provisional and that learning is an open process with no fixed endpoint. From a resonance theoretical perspective, this vision is rooted in the belief that the area of study, even at an advanced stage, continues to tell something genuinely new. However, if teachers view the learning material as closed and inert, they risk narrowing students' learning to a one-dimensional process that concludes once the scientific norms are mastered (Rosa, 2019). In contrast, resonance-sensitive teachers cultivate the idea that the learning material is multifaceted enough to reveal new insights even after a considerable level of mastery has been achieved. Much like expert musicians who continue to discover new aspects of a composition they have played repeatedly, mastery in a specific area of study does not result in mute relationships with nothing left to discover. Instead, it allows an ever-deeper dialog with the material (Rosa, 2020). To foster this idea in students, creating resonant experiences is crucial, as these experiences help establish stable axes of resonance to biology, transforming students into independent learners with a lifelong desire for inquiry and learning. The same is true for teachers: they need to cultivate stable axes of resonance to biology to maintain their curiosity and fascination for the field. Even after many years of engagement, biology should continue to reveal something new to them, sustaining exploration and learning throughout their entire professional lives.

## 4.6 Overarching pattern: rationalization of teaching and learning

Overall, the reconstructed patterns of noticing suggest that pre-service and in-service teachers share a highly rational vision of what constitutes good teaching and learning. Rationalization of teaching and learning is the overarching pattern that anchors our five patterns together and shapes participants' noticing of classroom events on the most fundamental level. Introduced by the sociologist Max Weber (2005), the concept of rationalization refers to the ideal-typical belief in modernity that everything, including teaching and learning, can be managed, improved, and optimized through rational planning and control, thereby minimizing uncertainty. The process of rationalization involves increased formalization, standardization, and evaluation of processes, leading to a proliferation of instrumental action and output-orientation, and promoting the growth of bureaucracy to shape human interaction (Rosa, 2019). However, the flipside of rationalization is that individuals may find themselves trapped in an "iron cage" (Weber, 2005, p. 160), where they mindlessly adhere to preset organizational procedures, standards, and goals at the expense of spontaneity, flexibility, intrinsic motivation, affective action, and personal relationships.

In the context of teacher noticing, a rational vision helps participants observe and assess instructional quality criteria such as lesson structure, coherence, and alignment between aims, contents, and methods (Berliner, 1987; Klafki, 1995). However, rationalization can also lead to a "disenchanted" (Weber, 2005, p. 88) vision of teaching and learning. Essentially, the rationalization of teaching and learning neglects affection on all three axes of the didactic triangle (see Figure 3). Regarding the teacher–material axis, participants expect the teacher to master the material and prepare it for instruction. However, they often neglect to consider teachers' affection: is the teacher excited, fascinated, and "touched" by the material in a way that enables them to serve as a truly inspiring "tuning fork" for the students (Rosa, 2019, pp. 134, 246)? Interestingly, such questions are rarely addressed. From a broader cultural perspective, the neglect of affection in teachers' professional

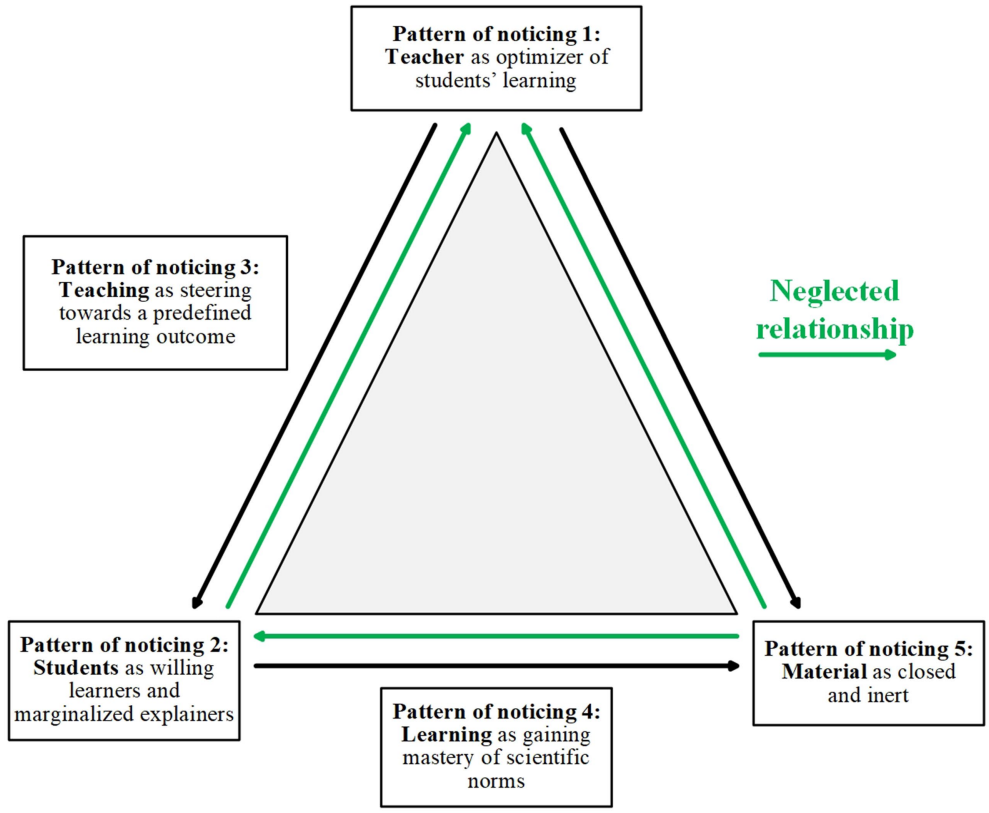


FIGURE 3
Didactic triangle and neglected relationships.

vision is the result of an increasing rationalization of teaching in the course of its professionalization during the twentieth century. To gain professional prestige and legitimacy, educators turned education into a "technical matter" (Labaree, 1992, p. 149), where professional knowledge is prioritized while the teacher's affective relationship with the material is largely neglected.

A comparable situation exists concerning the students–material axis: participants hardly consider whether students are affected by the material and find it meaningful for their own lives. Instead, the focus is on learning outcomes, specifically whether students gain mastery of scientific norms. Deviations from scientific norms are primarily seen as obstacles rather than as potential resources for learning. This professional vision is rational in the sense that participants evaluate students' learning instrumentally, in terms of achieving cognitive mastery of preset learning goals and well-established scientific norms, while neglecting the phenomenological nature of the learning process, particularly students' subjective experiences with the material. However, without experiencing the material as exciting and meaningful, it is difficult to see how students will develop an intrinsic interest and a desire for long-term engagement beyond the classroom.

Concerning the teacher-students axis, participants focus on how the teacher plans, steers, assesses, and controls students' learning. Teachers with such a technical vision tend to overlook moments in the classroom where students speak with their "own voice" (Rosa, 2019, p. 244) and present unexpected questions and ideas that cannot be fully anticipated in advance. However, from the perspective of resonance pedagogy, teachers must be open and responsive enough to engage with the inherent uncertainty and "semicontrollability" (Rosa, 2020, p. 44) that characterizes resonance in the classroom. This approach allows teachers to recognize, appreciate, and capitalize on "pedagogical moments" (van Manen, 1991, p. 507) that spontaneously arise. Yet, this can be challenging within schools as organizations that primarily aim to ensure that students efficiently achieve predefined learning goals. In such bureaucratic settings, the teacher is typically viewed as the instructor and the student as the learner (Luhmann and Schorr, 1979). Knowledge is expected to flow unilaterally, with teachers shaping students' understanding, but not the other way around. However, strict adherence to this stereotypical role assignment presents a significant barrier to a resonance-sensitive vision, as it systematically overlooks a core characteristic of resonant moments: the mutual transformation of both students *and* the teacher.

## 5 Conclusion

Inspired by resonance theory, we proposed resonance-sensitive professional vision as a new theoretical concept in research on teacher noticing. We explored how pre-service and in-service biology teachers' professional vision is shaped by an understanding of instructional quality informed by resonance. In doing so, we highlighted aspects of instructional quality often overlooked in teacher noticing research, particularly those related to a transformative approach to education or *Bildung* (Sjöström and Eilks, 2018). The reconstructed noticing patterns

serve as "analytic generalization" (Firestone, 1993, p. 16), providing insights that go beyond the specific case. Our analysis supports Goodwin's (1994, p. 616) conclusion that professionals share a specific way of vision that he calls "socially organized perceptual frameworks" that transmit norms. Our analysis shows that both pre-service and in-service teachers include only two aspects that can be interpreted as resonance-relevant: First, they construct students as willing learners, reflecting a generally positive belief in students. Second, their conviction in their ability to influence students indicates a high level of self-efficacy, which may support the creation of resonant conditions in the classroom—the "first tuning fork" (Rosa, 2019, p. 246). In contrast, the remaining results suggest that participants tend to rationalize teaching and learning, leading them to overlook key elements of resonance like the affective engagement of both students and teachers with the material. This overarching pattern raises important questions about practical implications, particularly in relation to the development of professional vision, as well teachers' job satisfaction, good professional life, and health.

## 5.1 Practical implications for teacher education

Rationalizing teaching and learning is an important sign of professionalism. In a bureaucratic school system with strict schedules, tests, and grading, teachers are responsible for ensuring that predefined learning outcomes are achieved within set time limits. However, an overemphasis on this rationalization, focusing solely on fixed learning outcomes while neglecting the broader concept of *Bildung* (Sjöström and Eilks, 2018), is problematic. As global education policies emphasize the importance of *Bildung* in official documents like curricula, teachers must consider each learner's unique characteristics and adapt to their specific needs, interests, and abilities. We argue that cultivating resonance-sensitive professional vision in teacher education can better prepare teachers to meet this challenge.

Beyond professional development, we argue that the rationalization of teaching and learning contributes to a growing "psychological crisis" (Rosa, 2019, p. 2), evident in rising rates of stress, burnout, and depression. Research shows that uncertainty tolerance is crucial for teachers' health (König, 2003; König and Dalbert, 2004; Dalbert and Radant, 2010; Spitzer, 2019). Dalbert and Radant (2010, p. 55) found that teachers with greater uncertainty tolerance experience higher job satisfaction, improved well-being, and fewer symptoms of burnout. However, our analysis reveals that teachers often hold unrealistic expectations rooted in rigid planning and control, driven by a need for certainty. Research also highlights major stressors like "time pressure" and "being evaluated by others" (Kyriacou, 2001, p. 29; Skaalvik and Skaalvik, 2017), which are heightened by these high expectations. Our analysis suggests that teachers frequently face criticism, which biases their professional vision toward deficits, leaving successes unnoticed. Yet, teachers' health depends on experiencing success and managing demands with proper detachment (Hillert, 2007). A key implication is that teacher education should emphasize the contingent nature of teaching and learning (Helsper, 1996; Labaree, 2000). Existing approaches in teacher education can support this shift (e.g., Floden and Clark, 1988; Floden and Buchmann, 1993; Helsing, 2007; Steinwachs and Martens, 2025; Bonnet and Glazier, 2023, 2024).

## 5.2 Limitations

Future research on resonance-sensitive professional vision should address two key limitations. The first involves the social and situated nature of professional vision (Goodwin, 1994). Our data come from group discussions and interviews with pre-service and in-service biology teachers in Germany's state school system. While we believe the (over-)rational professional vision stems from general didactics that frame teaching as a controllable process, this influence may vary across different societies, school systems, subjects, and career stages. For instance, biology, as a natural science, often treats scientific norms as more objective than subjects like social sciences or the arts (Heitmann et al., 2017), which could shape how teachers evaluate students' conceptions (Decke-Cornill and Gebhard, 2007). Comparative studies in diverse contexts are needed to explore these differences. The second limitation involves the use of an existing dataset originally produced for a different research purpose (Steinwachs and Martens, 2022). The video clip used as a stimulus for focus groups and interviews was not specifically designed to study resonance-sensitive professional vision. For example, face pixilation for anonymity hindered participants from observing more nuanced emotional expressions. Future studies should use more targeted stimuli to capture moments of resonance and alienation in the classroom better. These limitations highlight the need for further research to investigate how different contexts and tailored data collection methods affect professional vision.

## 5.3 Future perspectives

A potential direction for future studies is to investigate empirically how resonance-sensitive professional vision can be professionalized. It would be useful to explore the practical limitations within existing educational structures. Structural conditions in schools and teacher education hinder the development of teachers' ability to notice and interpret lessons through a resonance-sensitive lens. In schools, the focus on learning outcomes (Beljan, 2019), and in teacher education, the emphasis on rationalization for professionalization, have turned education into a "technical matter "(Labaree, 1992, p. 149), where professional knowledge is prioritized while an affective relationship with the material is largely overlooked. Thus, resonance-sensitive professional vision can only be taught and learned to a limited extent, and achieving broader implementation may require significant institutional reforms and structural changes (Rosa, 2020). Beyond the question of professionalization, exploring the connections between teachers' health and resonance sensitivity could offer valuable insights for improving teacher education.

# Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: Some excerpts from the transcripts are presented in the manuscript. Further transcripts can be received upon request to the authors. Requests to access these datasets should be directed to Jens Steinwachs, jens.steinwachs@uni-muenster.de.

## Ethics statement

In accordance with the local legislation and institutional requirements, ethical approval was not required for the study involving human samples. Written informed consent to participate in this study was provided. Written informed consent was obtained from the individuals for the publication of any potentially identifiable images or data included in this article.

## Author contributions

JS: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. JK: Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. MR: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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