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Science Teacher Professional Development for Inclusive Practice

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Abstract
Most subject teachers are not specifically educated for inclusion. Inclusive practice at classroom level remains a blind spot. This case study provides insight into the inclusive practice of two science teachers by video-based participant observation and then uses the data as a basis for professional development. The videos were recorded in an inquiry-based science class of an urban "inclusive middle school" in Austria. The two science teachers of this class reflected upon their own instruction. Three more science teachers reflected upon the others' teaching. The focus of the study was on what the teachers noticed and reasoned as they viewed the videos. The reflective sessions were audiotaped. Grounded Theory was used to analyze and compare the data. Surprisingly, the results show that inclusion was not often addressed and it was especially difficult to discover in others' teaching; however, implicit connections to inclusive, but not subject-specific teaching principles, can be drawn.

Keywords
Inclusion, Inquiry-based science teaching, Professional vision, Reflection, Video-based study

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State of the literature
- Secondary subject teachers' pre- and in-service education does not address inclusive practice.
- Successful professional development is a long term endeavor, happening best as a collaborative inquiry, oriented to the needs of the participants, with time to implement the addressed aspects into the local contexts, and offering opportunities to reflect.
- Watching video-taped instruction has been found beneficial for teachers' learning. Teachers watching their own lessons are more motivated by the videos than teachers watching others' teaching. Internal teachers, however, are less critical and identify fewer alternatives than external teachers, probably due to their emotional involvement.

Contribution of this paper to the literature
- Which notions and reasoning processes can be identified when reflecting upon inclusive practice in the context of an inquiry-based science class and what are the differences between the notions and reasoning processes concerning the inclusive practice of the science teachers watching their own practice and experienced science teachers watching others' instruction?
- Both groups, i.e. the science teachers watching their own practice and the experienced science teachers watching the others' instruction, do not mention inclusive practice or the vision of inclusion when analyzing the videos. Noticing students' individual conditions in other's practice is difficult.
- No subject-specific alternatives are discussed, which could indicate how rarely science teachers think of their subject related to inclusion.

Introduction
Almost worldwide, countries ratified the UN convention committed to implementing inclusive school systems (United Nations, 2006). Thus, inclusion is politically enacted. This development was long overdue; however, the top-down process is problematic. The implementers of inclusion in schools, namely teachers, have been overlooked and they have not been educated for inclusive practice (Jensen, 2010). Secondary subject teachers' pre- and in-service education does not focus on inclusive practice (Abels & Schütz, 2016; Amrhein & Reich, 2014). Competences such as observing and diagnosing learning needs, differentiating or individualizing are often not part of their professional development (PD). In Austria, inclusion has only been gradually integrated into university curricula (Abels & Schütz, 2016), but teacher educators who are competent in inclusive subject teaching are rare.

Inclusive practice is a rather new topic in science education and science education research. Researchers tend to focus on effective instructional strategies, students' with special needs, learning achievements or teachers' attitudes (Avramidis & Norwich, 2002; Scruggs, Mastropieri & Okolo, 2008; Therrien, Taylor, Hosp, Kaldenberg & Gorsh, 2011). Less is known about the skills and knowledge subject teachers require for inclusive instruction. There is a need for research into the authentic inclusive practice at classroom level as well as what constitutes successful professional development of (science) teachers' competences for inclusion (Florian & Black-Hawkins, 2011; Symeonidou & Phtiaka, 2009).

What is known in general is that successful professional development is a long-term endeavor, happening best as a collaborative inquiry, oriented to the needs and emotions of the participants, with time to implement the addressed aspects into the local contexts, and offering opportunities to reflect (Naraian, Ferguson & Thomas, 2011). Darling-Hammond, Hyler and Gardner (2017, p. v) "define effective professional development as structured professional learning that results in changes in teacher practices and improvements in student learning outcomes." According to Strieker, Logan and Kuhel (2011, p. 1048f), key-factors are: "(1) on-going emotional and technical support at the classroom level; (2) a forum through which to articulate and understand their beliefs, and how those beliefs influence daily practice; and (3) professional learning that is student-focused." In the meta-study of Darling-Hammond et al. (2017, p. v), seven features of effective job-embedded professional development were found: It is "content focused", "incorporates active learning", "supports collaboration", "uses models of effective practice", "provides coaching and expert support", "offers feedback and reflection", and "is of sustained duration".

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The research and development project presented in this article focuses on authentic inclusive practice at the classroom level while observing the mentioned key-factors for successful professional development. The researcher – with expertise in special needs education, science education and reflective teacher education –collaborated with two science teachers for one school year to further inclusive science education. Video-based participant observation was used to learn about inclusive practice in detail. However, since observation alone does not explain why a teacher chooses a certain action (cp. Spratt & Florian, 2015), the two science teachers were invited to explicitly reflect with the researcher upon selected videos recorded in their classrooms. The aim was to understand what they noticed in and how they interpreted their practice in an inclusive learning environment. This approach was associated with the concept of professional vision (see next section). In the long run, informed by the gained evidence and in line with aims of continuous professional development (Darling-Hammond et al., 2017; Loucks-Horsley, Love, Stiles, Mundry & Hewson, 2003), it was expected that the professional knowledge of the teachers would increase, and their teaching practice would develop in terms of inclusive teaching principles (see section 2.1). Other science teachers and teacher educators would also benefit from insights gained.

To sum up, this article examines the science teachers' reflections on video-taped inclusive practice. The concept of professional vision will be explained before the concept of inclusion is clarified.

Theoretical Framework of Professional Vision

The concept of professional vision was first defined by Goodwin (1994, p. 606) as "socially organized ways of seeing and understanding events that are answerable to the distinctive interests of a particular social group." In her work, Sherin (2007) transfers this concept to classroom events. She describes professional vision by two subprocesses that are interrelated and influence each other: first, selective attention and second, knowledge-based reasoning. "Both components affect what is noticed and how events in a classroom are interpreted" (Seidel, Stürmer, Blomberg, Kobarg & Schwindt, 2011, p. 260). The first one, selective attention, refers to the aspects a teacher notices and pays attention to while watching a video of classroom action. It is not about perceiving every aspect in a video scene, but about highlighting the relevant situations (Schwindt, 2008). Sherin and van Es (2009) distinguish between noticed topics and noticed persons, who are drawn into the center of attention. The second subprocess, knowledge-based reasoning, can be identified when a teacher explains the noticed aspects on the basis of his/her knowledge and experience. This subprocess is divided into three approaches to discussing a video: describing, evaluating and interpreting (Sherin & van Es, 2009). Schwindt (2008) explicitly identifies developing alternatives as part of the reasoning process and as a high manifestation of competence, mostly shown by persons with high expertise.

Generally, video has been shown to be a powerful, complex, rich, enduring, authentic and flexible tool that allows for in-depth analysis from multiple viewpoints (Goldman, 2007; Janík, Seidel & Najvar, 2009). Accordingly, watching video-taped instruction has been found to benefit teachers' learning (Gibbons & Cobb, 2017). It gives teachers "unique opportunities (…) to make multiple connections to their own teaching and to activate prior knowledge and experience" (Seidel et al., 2011, p. 260). Video can motivate teachers to improve their teaching by learning from their own or others' instruction and has been shown to be effective for professional development (Sherin, 2004; van Es & Sherin, 2008). The use of video further improves the ability to analyze teaching (Alsawaie & Alghazo, 2010; Borko, Jacobs, Eiteljorg & Pittman, 2008). To be able to analyze teaching practice from multiple viewpoints is a requirement for productive reflection. Expert teachers demonstrate this ability (Davis, 2006).

Video also gives continuous access to the teaching practice to be analyzed, which allows distancing from the action. Seidel et al. (2011) showed that teachers watching their own lessons are more motivated and activated by the videos than teachers watching others' teaching. They also found, however, that the former are less critical and identify fewer alternatives than external teachers, probably due to the emotional involvement. These results were confirmed by Kleinknecht and Schneider (2013). Consequentially, Lefstein and Snell (2011) argue that professional vision should be seen as a social practice in a social context rather than just cognitive abilities of noticing and reasoning.

Accordingly, in this study not only were the cooperating teachers invited to reflect upon their own inclusive practice, but three expert teachers not involved in the project were also asked to watch the same videos. Thus, it was possible to contrast the notions and interpretations of the same video scenes recorded in the social context of inclusive science classes. Before introducing the context further, inclusion is defined.

Theoretical Understanding of Inclusion

Inclusion is a contested concept defined in various ways. One definition that works well within the context of education and teaching is the following. It emphasizes that inclusion is a process that is based upon changes in common teaching approaches.

> "Inclusion is seen a **process** of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures and communities, and reducing exclusion within and from education. It involves changes and modifications in content, approaches, structures and strategies, with a common vision which covers all children of the appropriate age range and a conviction that it is the responsibility of the regular system to educate all children" (UNESCO, 2005, p. 13, original emph.).

Responding to the diversity of all students means to not only focus on special needs, like many school systems still do, but to also address all dimensions where human beings can differ, including mental and physical abilities as well as gender, age, socio-economic background, religion, sexual orientation, ethnicity etc. (Krell, Riedmüller, Sieben & Vinz, 2007). Different manifestations of these dimensions can affect learning in school subjects as they may influence language abilities, motivation, interest, prior knowledge or accustomed ways of learning.

Due to demographic changes and globalization, teachers are aware that their classrooms are becoming increasingly diverse (Markic & Abels, 2014) and of course, they encounter the differences in every class and lesson. The idea behind inclusion is to welcome diversity as an asset, appreciating and using everybody's strengths for individual and joint development instead of seeing differences as problems. The latter would be classified as integration, not inclusion, where deficits of some students need to be compensated (Sliwka, 2010). However, in most current school systems, it "is understandably difficult to maintain a positive attitude if political decisions, the provision of resources, societal demands or the quality of teacher education contradict inclusive school systems. Teachers who nevertheless try to meet the demands of inclusion have to be praised" (Abels, 2015, p. 78).

There are indeed many ideas about how to teach inclusively, mostly developed by general or inclusive education, but it is difficult to transfer these suggestions to different school subjects (Abels, 2015; Musenberg & Riegert, 2014). Florian and Black-Hawkins (2011) suggest implementing inclusive pedagogical approaches in classrooms rather than additional needs approaches. Additional needs approaches advocate teaching most learners in the same way and differentiating the content for some, which seems to be very challenging for subject teachers, as they teach few hours in many different classes. Thus, they do not have the resources to diagnose individual learning needs and adapt the content and methods accordingly. In contrast, inclusive approaches are open learning formats which allow all learners to participate according to their preconditions in their "zone of proximal development" (Vygotsky, 1978). Inclusive approaches are constructivist approaches, for example, project- and problem-based learning, station learning and other individualized forms stemming from reform pedagogy. In line with inclusive teaching principles, the instruction should be learner- rather than content-centered, initiate more group work and cooperation than single person working and competition, and be based on feedback and support instead of assessment with the aim of selection (Feyerer, 2012).

In science education, well-structured and scaffolded inquiry-based learning counts as an inclusive approach (Abels, 2015; Scruggs et al., 2008). "Science education fosters inclusion by facilitating participation in science specific learning processes for all learners. By appreciating the diversity and individual prerequisites, science education involves individual and joint teaching and learning processes to promote scientific literacy" (translated by Walkowiak et al., 2018, p. 270, from Menthe et al., 2017, p. 801). The following section will introduce inquiry-based learning in the context of the inclusive school where the two science teachers try to implement inclusive approaches into their daily school routine.

Inquiry-based Learning at an Inclusive School

This study takes place in an urban middle school in Austria, which is attended by students from grade five to grade eight in two to three parallel classes. All classes are integrative, which means that students with diagnosed special needs attend regular lessons. As students are classified in terms of abilities, the school is not inclusive (cp. Sliwka, 2010), but the teachers try to implement the vision of inclusion as much as possible in the current Austrian school system (cp. Abels, 2014). In Austria, there is still a segregated school system with many different types of schools for students with different achievement levels.

One example of the middle school's attempt to implement inclusive science education is the development of an open learning environment called Lernwerkstatt[†], a kind of workshop center, which can be classified as an inclusive approach (Abels, 2015). Lernwerkstatt is an open inquiry setting, i.e. the responsibility for all steps of an inquiry should be taken by the students (Blanchard et al., 2010; **Table 1**). The aims of inquiry learning are to learn scientific content, to learn to do inquiry and to learn about inquiry (Abrams, Southerland & Evans, 2008).

Table 1. Levels of inquiry (Blanchard et al., 2010, p. 581)

	Source of the question	Data collection methods	Interpretation of results
Level 0: Verification	Given by teacher	Given by teacher	Given by teacher
Level 1: Structured	Given by teacher	Given by teacher	Open to student
Level 2: Guided	Given by teacher	Open to student	Open to student
Level 3: Open	Open to student	Open to student	Open to student

Lernwerkstatt was initially developed by Karin Ernst in Berlin, Germany, in 1980, based on the New York workshop center by Lillian Weber (Ernst, 1996; Weber, 1977). "A Lernwerkstatt is described as a room where learners encounter stimulating phenomena, objects and materials which are supposed to trigger questions in their own field of interest (…) to start immediately with an inquiry" (Puddu, Keller & Lembens, 2012, p. 154).

In the middle school, every class has a three-day Lernwerkstatt once a year and more recently twice a year. As it is an open inquiry setting, the teachers only give students the superordinate topic, e.g. water, insects or light and color. The students come up with questions inspired by the materials in the Lernwerkstatt, choose and phrase a question they want to work on, conduct an inquiry and present their results in a self-organized activity at the end (Abels & Schütz, 2016).

[†] Lacking an appropriate translation, the term *Lernwerkstatt* is used throughout the article.

The process is documented in a lab journal. To support the students during their self-dependent work, the process of doing inquiry is scaffolded by coaches; in this case, there are two science teachers (one chemistry and physics teacher as well as one biology teacher), usually assisted by the classroom teacher and sometimes student teachers.

To develop the competences needed for open inquiry, the first Lernwerkstatt of each class is designed as a structured inquiry (level 1). The students work at stations where they learn scientific methods, for example, to observe, to measure, to compare, and to hypothesize. Each station invites students to pose an additional question into which they could inquire. At the end of the day, the teachers reflect with the students upon the methods learnt, the questions found and if they are researchable as well as the differences between school science and "real" science. The focus on phrasing questions has been found to be important as it is a crucial, but difficult step in open inquiry learning (Abels & Schütz, 2016; Hofstein, Navon, Kipnis & Mamlok-Naaman, 2005). The scaffolding conducted by the teachers is extremely important and was found to be crucial for successful inquiry-based learning processes (Abels, 2015; Scruggs & Mastropieri, 2007).

Because of these findings, the process of finding and phrasing questions was chosen as a phase to be reflected upon by the teachers. How this was empirically approached will be described in the next part of this article.

Research Design

Ten Lernwerkstatt classes were video-taped. Plenum discussions were taped from a teachers' and a students' perspective with two cameras; inquiry work was video-taped with three cameras focusing on small groups of learners. The two science teachers teaching the Lernwerkstatt wished to reflect upon video scenes of the Lernwerkstatt to better adapt to students' diversity. In an earlier study, Abels (2014), a first reflective meeting was analyzed and provided insight into the scaffolding of an inclusive inquiry-based learning environment; however, the topic of inclusion rather remained implicit.

In this study, follow-up questions were posed to better understand the utterances the two teachers made during the reflective meeting. Their utterances as well as their activation of knowledge and experience in an inclusive setting could be influenced by their involvement in the project and by watching their own teaching (cp. Seidel et al., 2011). Thus, their discussion of the video scenes was compared with discussions of other experienced teachers not involved in the project. The following questions led the data collection and analysis:

1. Which notions and reasoning processes can be identified when reflecting upon inclusive practice in the context of an inquiry-based science class?
2. What are the differences between the notions and reasoning processes concerning the inclusive practice of the science teachers watching their own practice and experienced science teachers watching other's instruction?

The researcher selected two video scenes of the Lernwerkstatt for reflection (for the description of the scenes see below). The two scenes were selected because they show the process of finding questions is crucial to starting open inquiry processes of individual interests (Hofstein et al., 2005). During this process, the teachers are required to offer an adapted scaffolding to support every student in finding a question and thus ensure participation during the Lernwerkstatt for all students.

The scenes were analyzed and interpreted first by the researcher, following the initial, focused and theoretical coding procedure of Grounded Theory (Charmaz, 2006) with technical support of the qualitative data analysis program ATLAS.ti (version 7.5). Through the initial or open coding, it was possible to retain the researchers' perspective and compare it to the viewpoints of others watching the video scenes without limiting or skipping important aspects by the use of a deductive category system. Such an inductive procedure was appropriate to reconstruct the implicit relations to inclusive principles. For the next step of focused coding, the initial codings were clustered in accordance with the areas of teacher knowledge (Bromme, 1992; Dann, 2008; Shulman, 1987), where the following domains are distinguished: content knowledge, pedagogical knowledge, pedagogical content knowledge, curriculum knowledge, knowledge of students and their characteristics, contextual knowledge as well as knowledge of educational aims, intentions and values (Shulman, 1987).

Charmaz' Grounded Theory approach was chosen as her constructivist version of Grounded Theory is particularly suitable for the analysis of social interactive phenomena. It can be distinguished from Glaser's original approach by strategies such as "beginning research with a literature review, making accuracy a central concern, transcribing interviews, and sample size. Glaser and his followers do not explicitly attend to epistemological questions about data collection and quality, research relationships, and researchers' roles and standpoints" (Charmaz, 2012, p. 3).

The constructivist approach is more appropriate given current viewpoints and standards in science education and science education research. In the context of inclusive practice, certain teaching approaches and values are more in line with the vision of inclusion than others (see above). Following Charmaz, this standpoint of a researcher can be considered during data analysis.

After the video scenes were analyzed by the researcher, two sessions were initiated with two different groups of teachers who watched the same two video scenes: the two teachers involved in the project watching their own instruction (IT, **Table 2**) and three non-involved experienced teachers (nIT) who were also working on their PhDs in science education. The sample size is limited to inductively explore the discussions in detail. In Grounded Theory, sampling strives for "development of a theoretical category, not sampling for population representation" (Charmaz, 2012, p. 3). The video scenes were shown to both groups, who were initially asked the general question of what occurs to them while watching the scenes. Each session lasted approx. 100 minutes, including the presentation of the two video scenes.

Table 2. The sample of the study

	nIT1	nIT2	nIT3	IT1	IT2
Teaching experience	23 years	26 years	7 years	31 years	27 years
Type of school(s)	Grammar school	Vocational school	Grammar school	Middle school	Middle school
Experience at an inclusive school	None	25 years at schools with high diversity concerning ethnicity, culture and religion	None	17 years at an inclusive middle school focusing on ability and ethnicity as diversity dimensions	Most of the teaching time spent at an inclusive middle school focusing on ability and ethnicity as diversity dimensions as well as in classes only for students with special needs
Level	Lower and upper secondary	Lower and upper secondary	Lower and upper secondary	Lower secondary	Lower secondary
Science subjects	Chemistry	Chemistry, physics	Mathematics, physics	Biology, mathematics, *Lernwerkstatt*	Chemistry, physics, biology, mathematics, computer science, *Lernwerkstatt*
Study	Teacher training certificate for chemistry and history at a university	Teacher training certificate for chemistry and physics at a university	Teacher training certificate for mathematics and physics at a university	Teacher training certificate for mathematics and biology at a college of education	Teacher training certificate for math, informatics and physics/chemistry at a college of ed.
Research Experience	8 years	6 years	1 year	None	None
Experience in providing PD	7 years	14 years	3 years	Occasionally	Occasionally

nIT: non-involved teachers,
IT: involved teachers

First, the meeting with the non-involved expert teachers took place to investigate what they saw in the videos of others' inclusive science instruction. These non-involved teachers knew that the same video scenes would be reflected upon by the teachers in the video. After the meeting, the utterances of the non-involved teachers were compared to the interpretations of the researcher. For one, this served as a validation of the researcher's viewpoint, who as a participant observer was deeply involved in the project. For another, this procedure allows for contrasting cases, an important step in Grounded Theory (Charmaz, 2006). Each session with a different group of teachers is demarcated as one case. Second, the reflective session with the involved teachers was scheduled in their school. This session aimed at reflecting and developing the Lernwerkstatt in terms of inclusive pedagogical approaches. The researcher's intention was to come up with and discuss alternatives the involved teachers could use and apply.

The reflective meetings were structured in line with the ALACT-model (Korthagen, Loughran & Russell, 2006, p. 1028) with the steps "action, looking back on the action, awareness of essential aspects, creating alternative modes of action and trial" (emphasis by author). This is a well-tried method of reflecting on teaching practice, except that it is only the involved teachers actually doing the action and the trial. But through the tool of video, both groups are enabled to look back on action, to become aware of certain aspects and to phrase consequences, which confirms the activating effect video can have.

The reflective meetings were audio-taped, transcribed and analyzed using Charmaz' constructivist Grounded Theory version with technical support of the qualitative data analysis program ATLAS.ti. A "categorical system with a certain level of abstraction" had to emerge (Breuer, 2011, para. 2). This qualitative data analysis based on audio and video recordings has the potential to provide in-depth understanding of social situations and to explain behavior or communication patterns that were not evident before (Griffiths, 2013; Nilsson, 2012).

The Selected Video Scenes

To understand the results, the reader needs to know what is happening in the two video scenes. Both scenes show the plenary assembly room in the school, which is used to organize the Lernwerkstatt with the students or to reflect upon the work already done. The scenes were filmed with two cameras, one taping the students' perspective, one recording the teachers' perspective. The two scenes were selected as they show a crucial and extremely challenging phase in the beginning of the inquiry-process – framing and finding a scientific question (cp. Hofstein et al., 2005). This is a decisive phase that determines whether all students are able to find a question of interest and thus can participate successfully throughout the project.

The first scene is about approx. 25 minutes. There are 20 eighth grade students with and without special needs presenting all the questions (between one and up to 15 questions per person), which they phrased after being inspired by the materials in the Lernwerkstatt on the topic "light and color". Students asked, for example, how a laser pointer works, why we need so much electricity, how electricity is transformed to light, how a distorting mirror works, how a kaleidoscope can be built etc. The questions are clustered by the biology teacher while the chemistry/physics teacher attaches umbrella terms to each cluster (see the green cards in **Figure 1**).

Figure 1. Clustering of students' questions (cp. Abels, 2014)

The second selected video scene is approx. four minutes long. It shows how the students decided which question they wanted to explore for the next days and with whom they wanted to work. The students' choice is documented on the green cards (see **Figure 1**) and coaches are assigned for each group. Afterwards the students start to inquire into their topic/question.

These two scenes were watched with the two groups described above, the non-involved teachers and the involved teachers, to see what notions and reasoning processes could be identified in the context of inclusive practice when talking about the same video scenes. The initial question of the researcher was: "What comes to your mind watching this video scene? What do you associate?" The results are presented in the following section.

Results

During the analysis, two aspects of professional vision stood out as particularly important, providing insight into inclusive practice. First, the topics the two groups mentioned during the reflective meetings give some indication of their ideas of inclusive practice at the classroom level. These notions will be presented in detail (see below The Notions of the Teachers). Second, there will be a closer look at the suggestions of alternative ways of teaching. This subcategory is referred to as alternatives (see below The Suggested Alternatives of the Teachers) and stood out as part of the reasoning process. The relations to inclusive practice are different for the two groups of teachers. In the following, the notions and alternatives are described, discussed and contrasted with each other before connections to inclusive teaching principles are drawn.

The Notions of the Teachers

The notions, in the form of open codings for both groups, are presented in **Table 3**, where they are clustered under headings (focused codings). The clusters were generally made in accordance with the areas of teacher knowledge (Bromme, 1992; Dann, 2008; Shulman, 1987), where the following domains are distinguished: content knowledge, pedagogical knowledge, pedagogical content knowledge, curriculum knowledge, knowledge of students and their characteristics, contextual knowledge as well as knowledge of educational aims, intentions and values (Shulman, 1987).

Both groups perceive certain aspects in the video that can be related to four of the seven domains just listed, whereby the domains are actually interrelated: content knowledge, pedagogical knowledge, pedagogical content knowledge as well as knowledge of students and their characteristics (see **Table 3**). Both groups are very aware of the pedagogical area although it has to be considered that the researcher first introduces or mentions these notions in the meeting with the involved teachers. The involved teachers refer to the students and their characteristics, which cannot be observed as intensely for the non-involved teachers.

Regarding contextual knowledge, the involved teachers make contextual references and show knowledge about their school; the other group does understandably not refer to the context.

The knowledge of educational aims is not referred to during the move of noticing, but the non-involved teachers hypothesize about the involved teachers' educational aims and intentions. Values are expressed, but mostly while criticizing certain aspects or suggesting alternatives; values are not explicitly noticed in the video:

(0695)‡ nIT3: well, I also think that one could do this more student-centered and tighter //
nIT2: // could do this more compact

Thus, the references made to the knowledge of educational aims are instead part of the other moves of professional vision than part of the notions. In both groups, no notions are made which refer directly to curriculum knowledge.

‡ The number marks the line in the transcript. Translations of the transcript were made as close as possible to the original German wording.

Table 3. Notions of the non-involved (nIT) and involved teachers (IT)

Notions	nIT	IT
Knowledge of Students		
Noticing amount and quality of students' questions	✓	✓
Noticing changed students' role	✓	-
Noticing students' use of Lernwerkstatt	-	✓
Noticing role of students' experience with Lernwerkstatt	-	✓
Noticing students' pre-conditions	-	✓
Pedagogical Content Knowledge		
Noticing quality of questions	✓	R
Noticing that questions become topics	✓	R
Noticing superordinate idea of Lernwerkstatt	✓	-
Noticing difference between school and research	✓	R
Pedagogical Knowledge		
Noticing attempt of IT to structure	✓	✓
Noticing challenge for IT to focus on whole class	✓	✓
Noticing challenge for students to be attentive because of the instruction	✓	✓
Noticing language of IT	✓	-
Noticing process of group formation	✓	-
Noticing social form	✓	R
Noticing scaffolding attempts	✓	R
Noticing missing structure	✓	R
Noticing missing structure has effects	✓	-
Noticing restriction without structuring	✓	R
Noticing different treatment of chosen topics	✓	-
Noticing classroom climate changed	✓	R
Noticing time frame	✓	✓
Noticing unclarity of aims	✓	-
Noticing gender	✓	✓
Noticing IT are doing most of the work	✓	R
Noticing design of room	✓	R
Content Knowledge		
Noticing role of IT' contentual expertise	✓	R

✓ = noticed, - = not noticed, R = researcher mentioned topic first

Notions Related to Inclusive Teaching Principles

Relating the notions to the social context of inclusion, it is obvious that both groups do not explicitly mention inclusive practice or the vision of inclusion. This means that the instruction seen in the video is not generally evaluated in terms of its appropriateness for a diverse class, although the involved teachers had expressed the desire to do so. However, certain implicit aspects of inclusion can be identified in the notions of both groups.

Most salient is that the involved teachers refer to students' experiences and pre-conditions, e.g., their knowledge and skills, behavior patterns or other personal characteristics.

(0598) IT1: (…) sitting quietly is exhausting for R.
IT2: yes and for L. especially

It may be trivial to point out that the non-involved teachers do not mention students' individual needs. However, this finding gives teacher educators some insight into the use of video vignettes. Noticing students' individual conditions in other's practice is a difficult endeavor as much background information is needed. Planning inclusive practice for unknown or hardly known classes – often asked in pre-service teacher education – probably does not result in individualized and specifically differentiated instruction. This is also an argument for focusing on inclusive pedagogical approaches in professional development courses (inquiry-, problem- or project-based learning), instead of additional needs approaches, as they can be designed without differentiating for specific needs (see section 2.1).

Also striking is the dominance of pedagogical aspects in the notions instead of subject-specific notions. Mostly, classroom management is addressed, which is an important factor in effective teaching practice (Hattie, 2009). The direct instruction approach, the learning goals, and the social form are preferentially noticed by the non-involved teachers. Of course, structuring, scaffolding, group formation are important aspects for inclusive practices as well (see section 2.1). Students with special needs are known to benefit from well-structured inquiry-based science education (Scruggs & Mastropieri, 2007). The relation to inclusion is not explicitly made by the teachers, but could probably be worked out easily, e.g., by a literature review or discussing principles of inclusive teaching. In contrast, the involved teachers do not mention the pedagogical aspects by themselves. The natural conclusion is to address this issue in pre- and in-service teacher education, first by reflecting on other's rather than one's own instruction to have an open mind for issues like classroom management.

Other aspects, which have been shown to be effective for inclusive education and could have been noticed in the video, were not mentioned, e.g., cooperative teaching or a (missing) variety of methods (Meijer, 2010). In addition, the barriers of the scientific topic for different students were not addressed.

Differences were not only observed in the move of noticing, but also in the move of suggesting alternatives, which will be elaborated upon in the following section.

The Suggested Alternatives of the Teachers

In the meeting with the non-involved teachers, the teachers develop all suggested alternatives without researcher interference. Sometimes the teachers explicitly ask to develop an alternative; it is probably a move they have learnt or even expect in teacher education settings. One teacher makes a suggestion, another takes it up, extends or criticizes it and further extensions are made before all three teachers approve and begin to develop alternatives for another noticed aspect (see **Table 3**). It is remarkable how they feed each other lines and come to an alternative way of teaching that seems applicable specifically for the situation they identified before as challenging. It seems as if they concentrate on the major issues where changes are needed the most, e.g., they suggest how to shorten the time frame of a certain phase or how more structuring could be provided (see following example in **Box 1**).

Box 1. Changes needed

commentating critically, suggesting alternative	(0671) nIT3:	yes, but why is the teacher clustering at all (…)
suggesting alternative, criticizing suggested alternative	nIT1:	yes, or the students must say where they would pin it on, but then it lasts even longer
criticizing suggested alternative	nIT2:	but then it lasts forever
suggesting alternative	nIT1:	on the other hand, the student does maybe not need to phrase twelve or 15 questions, but one can limit it to three in the first place
approving suggested alternative	nIT3:	limit it to three, well, I would just restrict the number of questions (...)
suggesting alternative	nIT1:	// no above all you could also say when everybody has only three questions we start with one question and who has a similar question
approving suggested alternative	nIT3:	exactly

In contrast, the involved teachers at first have difficulty suggesting alternatives. But as soon as the researcher draws their attention to a certain topic, they start developing alternatives. It seems as if the researcher has to help them see before they can overcome a barrier. An increasing enthusiasm is perceptible. The involved teachers extend their suggestions together with the researcher and develop them further very specifically for the particular setting. They are always very specific and detailed about a situation and try to adapt a suggested alternative to the concrete context, which is illustrated in the following example given in **Box 2**.

This means it is often the researcher's mention of topics or aspects that implies a need for change; the selective attention is often directed by the researcher. The involved teachers take the notion up, make their own remarks and critical comments and come up with very precise alternatives taking the specific situation into account. This seems to be a typical move for involved teachers (Borko et al., 2008).

Box 2. Adapting a suggested alternative

mentioning that questions are topics	Researcher:	what I also thought about what one really writes on the green cards, the students showed a remarkable performance (…), they almost all wrote questions
taking the topic up	IT2:	and we just slapped a headline (all are laughing)
mentioning that questions are topics	R:	(…) and they [the students] choose <u>topics</u>
taking the topic up	IT1:	hmm, they choose <u>topics</u> and not questions
mentioning that questions are topics	R:	yes, they choose topics (…), they choose the green cards
suggesting alternative	IT2:	that means one should phrase the green cards as questions
	R:	yes well
suggesting alternative	IT2:	or <u>not</u> again clustering, well, that we leave it without a question? or without a green card?
suggesting alternative	IT1:	just pinning a green card without writing anything on it? R: hmm, and then? what would be the next step?
extending suggested alternative	IT2:	that one thinks, these many questions, what could be (--) I don't know the basic question, yes, that one pins an empty green card
extending suggested alternative	R:	hmm, and then thinking together or the students, who are specifically <u>interested</u> in this area, that could <u>also</u> be done
extending suggested alternative	IT1:	that they [the students] meet and that they phrase the question
approving suggested alternative, Extending suggested alternative	IT2:	yes, exactly, that they phrase the question, that we do not predetermine this topic, but that we leave it empty

At the end of the reflective meeting, one teacher summarizes three developed alternatives, which she would like to implement next time. It seems as if the teachers want to keep the changes manageable and feasible. They agree with the researcher on meeting again after the trial phase. The three alternatives are (Abels, 2014):

- Students will cluster their questions topic-wise instead of teachers doing the mental work. The students are supposed to find core questions instead of umbrella terms.
- There will be clear rules for group formation.
- A criteria list for researchable questions will be developed and discussed with the students.

The teachers in Seidel et al. (2011), who watched their own instruction, "commented less critically and identified fewer consequences and alternatives" in comparison with teachers watching others' instruction (ibid., p. 266). As this study shows, this does not mean that the involved teachers are not able to comment critically and identify alternatives. Instead, it appears that they need an outside, but well-informed and benevolent person to guide them beyond a self-defensive mode.

All experienced teachers can be classified as experts, for one, because of their seniority and level of education, for another, because they are seen as professionals who can develop valuable solutions for their practice and teach accordingly (Dann, 2008). However, expertise is hard to define in the context of teaching (Berliner, 2001). According to the developmental model of Dreyfus and Dreyfus (2005), the acquisition of expertise is divided into five stages called novice, advanced beginner, competence, proficiency and expertise. The non-involved teachers show "situational discriminations" and decide what the important aspects are (Dreyfus & Dreyfus, 2005, p. 786). Additionally, they quickly see what to alter to achieve certain goals. This description is indicative of the stage 5 'expertise'. For the involved teachers, a classification is not that obvious. Their involvement seems to prevent them from seeing certain aspects clearly and from finding solutions immediately. It seems as if someone has to lift the curtain before they can show their full expertise.

The non-involved teachers know that it is difficult for the involved teachers to watch their own instruction. The involved teachers realize this challenge, but they also express how difficult it would have been for them to develop alternative ways on their own. For them, there seemed to be no need for change as the students followed the instructions in a mostly disciplined way. Watching the video and discussing it with the researcher made them realize the possibilities for further development (see **Box 3** below).

Box 3. Realizing the possibilities for further development

(0834) IT2:	I think it is good that one can see it from outside, you are somehow routine-blinded, right?
R:	definitely, sure, when you are involved, you don't see the forest
IT2:	and we conducted it [the Lernwerkstatt] a few times and it worked well (…), I mean, if we had done it with a class which behaved insanely, then we would not have kept it, then we would have said earlier that's not working and we would have had to come up with something

Alternatives Related to Inclusive Teaching Principles

Relating the suggested alternatives to the social context of inclusion, it is astonishing how detailed the involved teachers' discussion of one alternative is. They seem to imagine a certain situation with all barriers and pitfalls from the students' perspective, e.g., how they avoid chaos if more than one student comes to the board to present similar questions. The appropriateness of each alternative for the class and some individual students is thought through. This is especially important as the two science teachers collaborate, which requires additional attention and agreement; cooperative teaching is one central aspect of inclusion (Meijer, 2010). Also remarkable is that the involved teachers interpret the behavior of the students as disciplined, which signals from their point of view 'no change needed'. Generally, behavioral issues are one of the biggest problems for teachers in inclusive classrooms (Meijer, 2010). The absence of these issues seems to inhibit reflection.

In line with the dominance of the notions in pedagogical knowledge, suggested alternatives of the non-involved teachers mostly focus on classroom management; the noticed aspects are seized upon. The suggestions are to the point, but not that detailed and of course less student specific than those of the involved teachers.

To work with videos of other's instruction in teacher education seems to be a good idea to broaden the repertoire in classroom management, but only the reflection of one's own practice allows for changes that focus on the specific needs of the students to be taught.

Again no subject-specific alternatives are discussed, which could indicate how rarely science teachers think of their subject related to inclusion.

Implications and Conclusion

This study has yielded insight into the professional vision of science teachers in the context of inclusion. Existing research results could be corroborated, combined and extended. Grounded Theory with its core idea of contrasting cases has been shown to be an appropriate method to probe a social phenomenon taped on video, to analyze it systematically, to relate it to theoretical discussions and to gain inductively detailed knowledge about the social processes. This approach can enrich the current discussion about professional vision, teacher expertise in inclusion and the use of video in professional development settings. It was shown that the sub-processes of noticing and knowledge-based reasoning could be detected in both groups participating in this study.

Differences were found in terms of what aspects are noticed and how the video scenes are approached and reflected upon, especially concerning the development of alternatives. The involved teachers' professional vision comes to fruition with guidance from an outside, but well-informed person, which allows for the contextualized, specific development of alternatives. This puts the results of Seidel et al. (2011) about the notions of involved teachers in a different perspective, which should be further researched. The results of this study emphasize how important the social context for professional vision is. The moves 'noticing' and 'suggesting alternatives' were especially informative concerning inclusive practice.

So far, inclusive practice at the classroom level is an under researched topic in science education. On the one hand, the findings show that the teachers' involvement into the social context of an inclusive science classroom allows for noticing students' diversity and for developing specific alternatives for students' needs. On the other hand, this involvement can hinder teachers from noticing important aspects concerning, e.g., classroom management or subject-specific barriers and from demonstrating full autonomous expertise in developing alternatives. Teacher educators need to take a role as guide or coach, facilitating the processes of professional vision. It seems to be advisable to increase teacher awareness and to develop a certain repertoire of inclusive teaching approaches by first watching other's teaching and discussing it from a theoretical basis, before reflecting upon one's own instruction to evaluate the appropriateness of the chosen approach. But watching one's own teaching is an inevitable step in developing inclusive practice. What is important is to make inclusion and its practices an explicit topic to be discussed. This is also valid for inclusive learning and science learning, which were not related by the teachers. The researcher needs to make the discussion about inclusion subject specific. The contradicting demands of inclusion and science learning could be why they were not related (Abels, 2016).

The impartiality and expertise of the non-involved teachers as well as the context knowledge and emotional engagement of the involved teachers could enrich one another; they are a powerful combination for professional development courses and communities of practice. A well-structured reflective approach in the context of watching video-taped classroom action is beneficial for the professional development of all participants, the teachers and teacher educators. The next step is to investigate the implementation of the suggested alternatives, the trial phase of the ALACT-model.

Future studies could analyze how productive the reflective processes (cp. Davis, 2006) of the teachers are, and whether they do or do not implement the alternatives in their own science classes. Following the idea of design-based research, the theory-driven design of inclusive learning environments and their continuous implementation in science classrooms help to understand the barriers and facilitating factors of inclusive subject-specific practice (The Design-Based Research Collective, 2003).

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