Progress in Science Education
2022, Vol. 5, No. 2, page 48-63
ISSN 2405-6057
DOI.10.25321/prise.2022.1319

The analytical competency model to investigate the video-stimulated analysis of inclusive sciene education

Daniela Egger[1], Simone Abels[1]

Received: June 2021 / Accepted: March 2022

Structured Abstract

Background: Teachers are a key factor for an inclusive education for all learners. Science teachers are responsible for facilitating scientific literacy for all learners, reducing barriers and enabling participation to shape the society of tomorrow. Providing those opportunities means educating future teachers on how to plan, create and analyze inclusive science lessons for all learners and valuing diversity. Especially, the competence to analyze is seen as a necessity to develop high quality teaching.
Purpose: To understand the competency development of future teachers regarding inclusive science education, experts in this field are invited to analyze a video vignette showing inclusive science education. The experts identify and analyze inclusive science education within a video-stimulated reflection (VSRef) to create a reference norm for the investigation of future teachers' competencies. For the purpose of context-related data analysis, we developed a five-stage model to categorize the VSRefs: The Analytical Competency Model (ACM).
Sample/Setting: Our participants include experts in the field of inclusive science education (N=6): three PhD students and three post docs who do research and teach in inclusive science education. Five hold a Master of Education (biology, chemistry and/or physics for secondary schooling and one in primary education), one participant has a Master's degree in Special Needs Education. The range in age is 25-35 and all experts are from Germany.
Design and Methods: The experts watched a five-minute video vignette showing an inquiry-based learning setting on solubility. They were asked to observe, interpret and generate alternatives to the noticed teacher actions. We analyzed the VSRefs with a structured qualitative content analysis. We used expert validity to validate our ACM and calculated an intercoder reliability of the coding results regarding our ACM.
Results: The experts targeted all five stages with varying strength and showed high analytical competency in reflecting inclusive science education in the presented video-vignette. This will be illustrated and explained with examples of the experts' reflections.
Conclusions: Our ACM can be used in higher education to evaluate the success of seminars on the topic of inclusive science education. The experts' framing will be used in an investigation of a pre-service teacher sample to evaluate the development of their analytical competencies throughout a three-semester project-based seminar.
Keywords: *Inclusive Science Education, Professional Vision, Teacher Professional Development, Analytical Competency, Qualitative Methods, Video Analysis*

[1]Leuphana University Lüneburg
✉ daniela.egger@leuphana.de

1 Introduction

Teaching natural science subjects like biology, chemistry or physics is a challenge in itself. Many students prefer other subjects in school and show low interest, especially in chemistry and physics (Potvin & Hasni, 2014). It is even more challenging for science teachers to prepare lessons that are understandable to all students, especially concerning abstract concepts (Buxton et al., 2019). Accordingly, inclusion is often seen as an add-on challenge for teachers in preparing science lessons.

Teachers are a key factor for the inclusion of all students in science education. Already pre-service science teachers should be prepared for teaching in inclusive classrooms and heterogeneous learning groups. They need to acquire knowledge about teaching science inclusively and to develop confidence in teaching science in inclusive classes (Mumba et al., 2015). They need support in order to develop their competencies in inclusive science education, which is still a gap in research and practice (Egger et al., 2019). For many years, either this topic has been fully neglected by the fields' researchers or, when they did make it a subject of discussion, they only concentrated on certain diversity dimensions such as additional needs (Scruggs et al., 2010; Scruggs et al., 2008; Therrien et al., 2011; Villanueva et al., 2012).

In reaction to the depicted research gap, there has been more and more research initiated for the last decade, combining inclusion and science education (e.g., Menthe & Hoffmann, 2015; Abels & Schütz, 2016; Nehring & Walkowiak, 2017; Stinken-Rösner et al., 2020; Stinken-Rösner et al., 2021). Participatory science lessons have been designed and investigated to facilitate "Scientific literacy for all" students (e.g., Bybee, 1997a; Gräber & Nentwig, 2002; authors, 2020b). Inclusive science education is thereby understood as "(…) supporting all learners – while appreciating their diversity and their learning prerequisites – to participate in individualized and collaborative subject-specific teaching-learning processes for the development of scientific literacy" (Walkowiak et al., 2018, p. 270).

(Future) Teachers need to be prepared for the interconnectedness of inclusion and science education in reflective teacher education. Research points out that successful education requires "specialized generalists" to implement inclusion (translated from Sawalies et. al, 2013, p. 5). Therefore, universities face the challenge of redesigning curricula in the field of inclusive education and of implementing them together with subject-related education (Abels & Schütz, 2016). A combination of pedagogy and subject-related education can promote the process of participation and reduction of exclusion in our current school system (UNESCO, 2018). To provide scientific literacy for all students in schools, (pre-service) science teachers need to learn how to prepare, conduct, analyze and reflect inclusive science lessons. Especially, analytical competencies are a crucial part of their professional development (Krepf, 2019).

To investigate the competency development of pre-service teachers regarding their analysis of inclusive science education, we needed to develop a category scheme that allowed addressing the analysis of inclusion and science education in combination. The Analytical Competency Model (ACM) was created to be used in researching video-stimulated analysis of inclusive science classes. To illustrate the model, we present the conceptual framework underlying the development of the ACM and how the model is applied in our Nawi-In project (Teaching science education inclusively). This project is federally funded by the German Ministry of Education and Research (funding number: 01NV1731) and focuses on the competency development of pre-service science teachers facing the challenge of inclusive science education during their own master studies. Future teachers are given the opportunity to develop their competencies in planning, implementing, and analyzing inclusive classroom situations (Egger et al., 2019). The ACM is used specifically to investigate the analytical competency of becoming teachers regarding the analysis of other's and their own teaching. In the end, the results of the analyses with the ACM are combined with further results of our project, e.g., the self-report on being able to teach science inclusively, attitudes and self-efficacy, to create competency profiles of the pre-service teachers.

The main topic of this paper is the presentation of our Analytical Competency Model (ACM) and how it was constructed. To validate the ACM, it was in a first step applied on experts' analyses of inclusive science education (Lamnek & Krell, 2010). The results presented here facilitate a revision and improvement of the ACM for a subsequent use on pre-service science teachers' analyses of inclusive science education, which is the focus of the Nawi-In project .

2 Research background

2.1 Inclusive Science Education

Inclusive science education can be understood by the connection of two perspectives – the perspective of science education and the perspective of inclusive education (Stinken-Rösner et al., 2020). The synthesis of both perspectives means minimizing barriers to science learning and enabling participation so that all learners can achieve scientific literacy (Bybee, 1997b; Florian & Black-Hawkins, 2011; Stinken-Rösner et al., 2020). Science education needs a stance of inclusion appreciating individual potentials and the diversity of learning groups independent of age, gender, and cultural, religious or socio-economic background (Booth, 2003; Ainscow, 2007; Florian & Black-Hawkins, 2011; Florian & Spratt, 2013).

Regarding inclusive science education, researchers connected the aims of science education (Hodson, 2014) with inclusive pedagogy (Booth & Ainscow, 2016) and point out that there has to be a systematic change from concept- to context-driven approaches that make science relevant for everyone (Ferreira González et al., 2021). This idea was

extended in the *Nawi-In* project. The framework for inclusive science education was developed (Brauns & Abels, 2021a) and validated (Brauns & Abels, 2021b). The framework was applied in higher education to prepare pre-service science teachers for planning, conducting and reflecting inclusive science lessons (Brauns & Abels, 2021a; Brauns & Abels, 2021b). Video data was analyzed with the framework. Findings show what pre-service teachers notice in inclusive science education and how they reflect on their own inclusive science lessons after they conducted the planned lesson with the framework (Brauns & Abels, 2021b).
The development of the ACM is another contribution in the field of inclusive science education regarding the professionalization of pre-service teachers in terms of their analytical competency.

2.2 Analytical Competency

Analytical competency is seen as an essential part of professional knowledge and professional acting in teaching situations to achieve a relation of professional competency and professional practice (Kunter et al., 2013; Munby et. al 2002; Voss et al., 2015). It is understood as the ability to realize and evaluate observed teaching in its quality, e.g., regarding learning effectiveness (Plöger & Scholl, 2014). Being competent in analyzing lessons means to notice many different elements of situations and actions. To connect these elements is necessary for the evaluation of the analyzed lessons (ibid.).
In the professional development of (pre-service) teachers, analytical competencies play an important role for preparing and conducting lessons. To acquire high quality in planning and teaching lessons, teachers should analyze previous classes led by theory-based criteria. The achieved insights about teaching quality and learning effectiveness enable an ongoing development of professionalization (Plöger & Scholl, 2014). In the cycle of planning, teaching and evaluating lessons, analytical competencies are a crucial component (Krepf, 2019). Additionally, part of the analytical competency of teaching persons is to realize and classify the complex interplay of theory and action (Plöger & Scholl, 2014; Krepf, 2019)
For the investigation of analytical competency as an indicator for professional development, the novice-expert-paradigm is of particular importance. Novices and experts are utterly different in analyzing teaching situations (Plöger & Scholl, 2014; Krepf, 2019). Results in research of expertise show that cognitive activities and the degree of complexity of processed information are very different (Berliner, 2004; Palmer et al., 2005). Novices concentrate on isolated events and experts see the whole picture classifying teaching events as bigger units (e.g., teaching concepts, methodical concepts etc.) (Berliner, 2004; Plöger & Scholl, 2014; Krepf, 2019). When comparing novices and experts, it can be observed that novices focus on the analysis of isolated situations and on details which is classified as the 'visible structure' of teaching in the lower competency stage of Plöger's and Scholl's competency model (2014). Experts have a global view on teaching events and refer to the 'deep structure' of teaching. Experts synthesize the fast and classifying analysis of details with their global perception of teaching events (Carter et al, 1988; Plöger & Scholl, 2014). What first sounds like a contradiction is a complementary strategy of analysing complex teaching situations. Stages of Plöger and Scholls' model are (a) Analytical Competency ('visible structure'), (b) Synthesizing Competency and (c) Process Competency ('deep structure').
We found no former study that investigated analytical competency of pre-service science teachers, which we analyze in the specific context of inclusive science education in our project, and discussed their professional development from novice to expert. There are, however, studies where the analytical competency of pre-service teachers is framed by the concept of professional vision (Schwindt, 2008; Seidel & Prenzel, 2007; Sherin, 2001). Here, (becoming) teachers analyze classroom video scenes based on what they have noticed. Analytical competency can be considered as a basic skill of professional vision.

2.3 Professional Vision

Professional vision is understood as the ability to select and interpret relevant situations in a teaching- learning situation (Sherin, 2007). These two processes are distinguished as noticing and knowledge-based reasoning. The process of noticing gives researchers insights into the aspects, which teachers pay attention to watching a video scene on classroom action (Seidel et al., 2011). Reasoning means to explain the noticed aspects theory-, experienced- and knowledge-driven. There is close resemblance between professional vision and analytical competency, especially concerning the process of knowledge-based reasoning.
Studies on professional vision of teaching experts show, that they cluster classroom events and notice more complex structures in the presented lesson. They also find complex explanations for classroom events in activating their context-related knowledge (Seidel & Prenzel, 2007). Schwindt (2008) investigated professional vision of different groups of teaching personnel and created different criteria ("partial competencies") to rate the professional vision of the study participants. The experts were able to describe, interpret and evaluate classroom situations, classify and integrate classroom events in superordinate (subject-related) concepts, refer to coherences of different classroom situations and point out alternatives on action based on critical reflections. There are three main approaches in discussing a video scene: to describe, interpret and evaluate (cf. Schwindt, 2008; Sherin & van Es, 2009; Santagata & Guarino, 2011). Generating alternatives on action is an important part of evaluating video scenes (Schwindt, 2008).
There is a research gap regarding the analysis of inclusive science education in teacher education or – to be more specific – the analytical competencies that develop in the context of inclusive science teaching. In this paper, we present

the investigation of experts' competency analyzing inclusive and exclusive classroom situations in science education. The results serve to assess the competencies of pre-service teachers afterwards.

2.4 Models and Stages of Analytical Competency

The following models all address skill acquisition in different contexts, sometimes more general, sometimes more related to the context of our study. We used them to create an Analytical Competency Model (ACM) of our own, designed for our specific research focus. Before we explain our model, we give an overview of the underlying concepts and ideas.

(1) Adult Skill Acquisition Model by Dreyfus and Dreyfus (1986)

(2) Expert teachers: their characteristics, development and accomplishments by Berliner (2004)

(3) SOLO (Structure of Observed Learning Outcome) Taxonomy by Biggs and Collis (1982)

(4) Teachers' perceptions of classroom situations by Schwindt (2008)

(5) Model of analytical competencies by Plöger and Scholl (2014)

(1) Dreyfus and Dreyfus (1986) created the five stages of skill acquisition. They claim that an individual learns through written and verbal instruction, and through instruction and experience as a dynamic process. Each individual passes the stages from (a) novice, (b) advanced beginner, (c) competent, (d) proficient to (e) expert from the "rule-guided knowing that" to the "experience-based knowing how" (ibid., p. 19). The authors describe every stage of their model and characterize the abilities that each individual might possess at each stage of skill development. Dreyfus and Dreyfus claim that their model can be used for any existing profession and might help those who educate and those who are educated at each stage of their individual development (Dreyfus & Dreyfus, 1986). However, Berliner (2004) felt the need to specify the model for the teachers' profession.

(2) Berliner (2004) considers the Dreyfus and Dreyfus model and combines it with his own research about the professional development of teachers (ibid.). He connects every stage from the Dreyfus and Dreyfus model (1986) with the knowledge and expertise teachers in their professional development should gain on each stage of development. He concludes, "(…) there are no differences in the sophistication of the cognitive processes used by teachers and experts from other fields" (Berliner, 2004, p. 26). Additionally, he claims that the different stages would support teacher educators to adapt their courses and expectation of performance to the prerequisites of pre-service teachers, when they integrate and observe the different stages throughout teacher education (ibid.). Having related the skill acquisition model to the context of teacher education, we were looking for a model specifying those stages even more allowing us to integrate our complex context of inclusive science education.

(3) Biggs and Collis (1982) evaluated learning quality and analyzed material from all kinds of students from elementary school to college levels throughout different school subjects (history, geography, creative writing, reading, foreign languages and mathematics). They rated the responses of several hundred students to particular exercises in the different subjects. The result of the rating is summarized in the model (Fig. 1) divided into different stages of complexity as (a) prestructural, (b) unistructural, (c) multistructural, (d) relational and (e) extended abstract. They conclude that the stages and the maximum level of performance are determined by the task requirements and are limited by working memory, general cognitive abilities, the motivation to perform as well as the familiarity to the requirements (Biggs & Collis, 1982). The stages of complexity facilitate a relation to inclusive science education, which is a relational concept. In line with Berliner, we assume that novices – in contrast to experts – often discuss unistructural concepts, i.e., they discuss inclusion or science education without combining the perspectives. After specifying the stages as levels of performance, we needed to integrate the context of professional vision and video-based analysis.

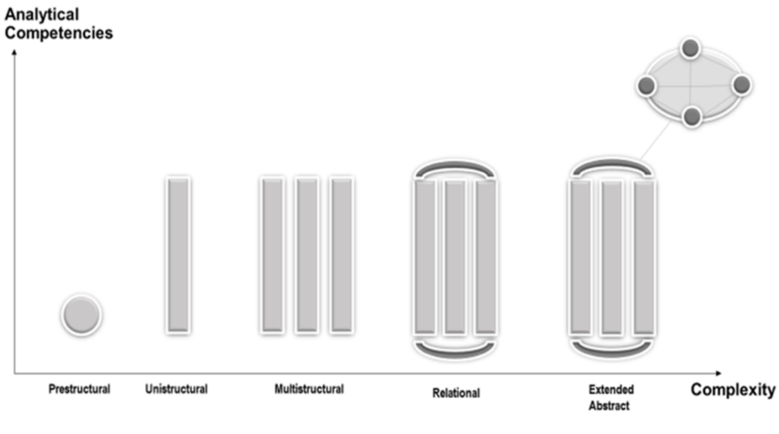

Fig. 1. SOLO-Taxonomy (after Biggs & Collis, 1982b, n.p.).

(4) Schwindt (2008) compares novice to expert teachers in rating videos of teaching situations. The focus of her study lies on the description of teachers' competencies to examine videotaped lessons, and how the teachers' competencies differ from their individual background of experience (ibid.). Schwindt's overall model of professional vision consists of several partial competencies that range in a scale from global to differentiated. The test persons had to analyze teaching situations in videos within a three-step analysis – (a) description, (b) interpretation and (c) and generating alternatives on action (evaluating). Schwindt's results determine that the professional vision of the pre-service teachers examining the videotaped lessons primarily stay on the descriptive level whereas experts are more differentiated and critical. In addition, the skill to analyze videotaped lessons is an indicator for the ability to analyze lessons in real situations (ibid.). Having integrated the concept of professional vision, we wanted to focus this even more on analytical competency, so we added another model.

(5) Plöger and Scholl (2014) investigate the analytical competency of teaching staff (pre-service teachers, in-service teachers and teaching educators). The modelling and measurement refer to the ability of teachers to assess and evaluate the quality of observed lessons. Their five competency stages are divided into (a) analytical competency (stage 1 and 2), (b) synthetic competency (stage 3 and 4) and (c) process competency (stage 5). In their findings, they show the difference between pre-service teachers and the other staff – the others showed more complex abilities and higher stages of analytical competency than the pre-service teachers (ibid.).

2.5 The Analytical Competency Model (ACM)

While the Dreyfus and Dreyfus model about skill acquisition in adult professionalization is very general, we aimed for a model that is adapted to our research focus in order to investigate analytical competencies of (1) experts in inclusive science education and – with that in mind – (2) the competency development of pre-service teachers regarding the analysis of inclusive science education. The focus of this paper lies on number 1, the experts' analytical competencies, to create a reference norm for investigating the competencies of the becoming teachers. The conceptualization of our ACM happened in different steps, which we present in the following.

The Dreyfus and Dreyfus model is the starting point of our competency model. The different stages of development from novice to expert are the basic structure of the ACM and give us an orientation to investigate our study participants' analytical competencies. However, we felt that the general Dreyfus and Dreyfus model did not capture the competency development in relation to *Nawi-In* in particular. Therefore, the second step was to find models that helped to identify competency development on the different stages enriching and contextualizing the Dreyfus and Dreyfus model by subcodes regarding video-based professionalization in terms of inclusive science education. The third step was to arrange the content of the different models at the stages of the general model and set up a description as a synthesis of all the content on every stage. We added Berliner (2004) and his findings about teachers and their professional development related to the Dreyfus and Dreyfus model (1986). That gave us a description of the different stages according to which we were able to classify the analytical competencies, but there was no indication about skills to analyze and to reflect inclusive science education in videos. The SOLO Taxonomy of Biggs and Collis (1982) was an appropriate tool to investigate the data in context to the experts' and pre-service teachers' analyses (audiotaped and transcribed, see chapter 3.1). With the systematics of the Taxonomy, we were able to identify on which stage the study participants could interpret the lesson sections they saw on video reflecting inclusive science education. To specify which aspects the participants would analyze in their reflection (Biggs and Collis also mention aspects in their study), we added four fields of knowledge to categorize the expected aspects identified in the teaching videos: general pedagogy, science education, inclusive pedagogy and inclusive science education. The last field is a synthesis of inclusive and science educational elements (chapter 2.1) and is linked to stage 3 (relational) and higher (Fig. 1). At stage 0-2 the participants do not identify inclusive science education as a related concept. Figure 1 illustrates that the different stages get more complex from left to right. Stage 1 (unistructural), for example, means that their argumentation is based on inclusive pedagogy OR science education, but they do not relate those concepts. Biggs and Collis (1982) call the different stages prestructural, unistructural, multistructural, relational and extended abstract. Related to our research, the stages are understood as follows:

- prestructural: misses point,
- unistructural: names one relevant aspect of inclusion OR science education,
- multistructural: combines several independent aspects of inclusion AND science education,
- relational: integrates aspects into a coherent structure of inclusive science education, and
- extended abstract: generalizes the aspects to a new domain.

The more complex and connected the study participants reflect about inclusion and science education, the higher are their contextualized analytical competencies.

The model of analytical competencies of Plöger and Scholl (2014) and Schwindt's (2008) findings about professional vision were included, because we needed tools that made an investigation of and statements about the content quality of the participants' reflections possible. Both studies have in common that the participants reached a higher level if they were able to have a holistic, but still differentiated view about the observed teaching. On a lower level, the study participants' competencies were characterized as a limited view on isolated events in the lesson sequences being observed. In addition, we used Schwindt's modus operandi of how the participants had to examine the video sequences in three steps – describing, interpreting and generating alternatives on action.

After the synthesis of all five different models, complementing each other, we specified a stage model about video-stimulated analysis of inclusive science education. Not every model of the above was used to specify every taxonomic stage.

Stage 0[1]: The participants do not comment expediently on the topic, miss the point and/or make factually wrong statements. Off-topic statements are classified as prestructural after the SOLO Taxonomy (Biggs & Collis, 1982a).

Stage 1: At this stage, the participants select an isolated (teaching) event but cannot connect it to other situations or theories. They verbalize general phrases of teaching and learning (Berliner, 2004). Experiences of school lessons from the study participants' past is more important than the theory of teaching and learning (Berliner, 2004). They rely on rules they have learned without context and follow them rigidly (recipe-knowledge) (Berliner, 2004; Dreyfus & Dreyfus, 1986). The study participant only names one aspect from one out of three fields of knowledge (general pedagogy, science education, or inclusive pedagogy; inclusive science education is not addressed at this stage). After Biggs and Collis (1982) this is coded as unistructural.

Stage 2: The participants evaluate isolated events and name various aspects of the three fields of knowledge. They summarize those isolated events unconnected in superior concepts of teaching without rating them as positive or negative and present the events in everyday language (Schwindt, 2008). They also verbalize experiences from their episodic and case-based knowledge (similarities and contexts). Their *wisdom of practice* (Shulman, 2004) is derived from positive and negative teaching experiences. That means they reflect experiences with various cases, events, success and failures, and change them into something meaningful wishing to integrate it into their own teaching practice (Berliner, 2004). Practical knowledge is verbalized in terms of seeing teachers as breaking, ignoring or following rules. The study participant cannot give reliable statements about consequences of their own or other teaching actions. At this stage, they name various aspects unconnected but parallel and place them more or less explicitly in one of the three fields of knowledge – not just one at a time like on stage 1, but still not connected to each other. This is called multistructural (Biggs & Collis, 1982).

Stage 3: At this stage, the participants are reflecting decisions about future acting, set priorities and rational goals in appropriately chosen ways. Isolated events are selected, classified and put into theoretical subject-related concepts (Biggs & Collis, 1982). The study participants differentiate at the base of their own practical knowledge between significant and insignificant events and take appropriate decisions about their choice of topics for teaching according to the curriculum (ibid.). Separate actions or effects that were caused by these actions are identified interpretatively and connected with each other to bigger unities of meaning (Plöger & Scholl, 2014). Additionally, individual actions or situations are calculated and anticipated (ibid.). They reflect as if they were the master of the situation, but stay slow, hesitant and rigid in their verbal action (Berliner, 2004). The study participants are able to connect superficially several relevant aspects of the four fields of knowledge with each other. At this stage, inclusive science education is identified, but not reasoned deeper. After Biggs and Collis (1982) this is called relational. We divided the relational level in relational A (stage 3) and relational B (stage 4).

Stage 4: At this stage, isolated (teaching) events are summarized and consolidated to bigger educational and methodical units (Plöger & Scholl, 2014; Schwindt, 2008). The study participants identify similar teaching events and present them in a holistic way (Berliner, 2004). Due to this holistic view, they can predict future teaching events precisely. Wide-ranging case knowledge is used for drawing predictions, even for problem solving (ibid.). Events are critically rated as positive or negative, justified, and possible consequences for students' behaviour are pointed out (Schwindt, 2008). (Behavioural) Patterns are recognized as disturbances, boredom, interest, confusion etc. (Berliner, 2004). In contrast to the relational A level at stage 3, the participants do not just identify inclusive science education. They integrate inclusive pedagogy into science specific concepts and connect practical and theoretical parts of inclusive science education with each other (after Berliner, 2004). Instead of referring to rules, they use their experience and case-knowledge transferring it to new events and reflect those in the video scenes (Berliner, 2004). This stage is called relational B.

Stage 5: The participants show high performance in reflecting events (from the video scenes). That means they articulate profound statements at the content level of inclusive science education without frequent reformulations and terminations (after Berliner, 2004). They verbalize their wide-ranging knowledge about inclusive science education and develop further subject-related ideas independently. They refer to their own deliberate analytical processes to analyze video scenes and to apply it on unusual situations (ibid.). Therefore, they focus on unexpected and atypical events. When there are no further disturbances, participants do not enlarge events, but they emphasize positive events (ibid.). In their analysis, they can generalize events over and above the video scenes. They take at least one out of three points of view (students, teacher or others and retrospective) and are able to transfer their ideas and new aspects to inclusive science education (after Biggs and Collis, 1982). Additionally, they are able to build several hypotheses about a possible further lesson process, rate the decisions made in the video scenes in a constructive way and theorize the seen (ibid.). Particular events are selected, described in terms of bigger units and rated with theoretical references. They propose ways of solutions for identified problems of inclusive science education (Berliner, 2004; Schwindt, 2008; Plöger &

[1] Stage 1 is a "pre-stage" in our model, which is important for the empirical use, but does not relate to the theoretically conceptualized model. It is listed here for completeness.

Scholl, 2014). Study participants at stage 5 can also provide educational-methodical reasoning, referring to the background of the whole teaching process (Plöger & Scholl, 2014). They explicitly name reasons for a (good/improvable) quality of lesson processes and indicate alternatives for the complete process at a very high level (Schwindt, 2008). This is the extended abstract level after Biggs and Collis (1982).

2.6 Research question(s)

The *Nawi-in* project focusses on the development of pre-service science teachers' competencies in performing and analyzing inclusive science lessons. The main research question in the project is: Which professional competency development of pre-service science teachers (primary and secondary schools) can be determined within two semesters of a project-based seminar? In one part of the project, we focus on analytical competencies regarding inclusive science education. The subordinate research question addressed in this paper is: Which analytical competencies do experts perform in a video-stimulated reflection regarding inclusive science education?
To answer this question, we analyzed video-stimulated reflections (VSRef) of experts with the ACM to build a reference norm. This norm allows us in a second step to classify and better understand the analytical competencies of the pre-service teachers.

3 Methods

3.1 Video-Stimulated Reflections

"The video-stimulated reflective process is a collaborative inquiry between research partners – teacher and researcher. It is intended to reveal teachers' thinking (...) about specific, classroom episodes which they choose to reflect (…)." (Powell, 2005, p. 408)
To reveal the process of the experts' knowledge-based reasoning (Sherin, 2007) we used the method of video-stimulated reflection (VSRef) (ibid.; Powell, 2005). The experts' reflection of a science lesson made it possible for us to investigate the level of analytical competency of our expert sample regarding inclusive science education to create a reference norm (see above). The expert sample contains six experts (3 PhD students and 3 postdocs) who investigate inclusive science education in their research projects. Every expert has a different (science) education background: Master of Education (and PhD) in biology, chemistry and/or physics education for secondary level or in primary science education. One expert has a Master in Special Needs Education (N=6).
In the process of data collection, every VSRef started the same way: After a pre-informational part about ethical issues like anonymization, recording in videoconferences and data use, the tasks were explained to the study participants. (The project was approved by the state supervisory school authority of Lower Saxony and the ethics committee of *anonymous* University. The study participants' informed consent was developed in consultation of the university's data protection officer in accordance with the German data protection act.) The experts got the instruction to (1) watch a five-minute video vignette and (2) select up to three sequences in which they could identify inclusive science education or moments of exclusion from science education. (3) They were allowed to take notes as the vignette was shown. Afterwards, the study participants got five minutes time to complete their notes. Subsequently, the first selected sequence was played back and (4) analyzed by the participants. First, they described the selected scene, second, they interpreted the scene regarding inclusive or exclusive science aspects and finally, they gave alternatives on action how to improve the teachers acting in this specific situation. The process was repeated a second and third time for the other selected scenes. The length per VSRef is approx. 45 minutes. They were recorded via videoconference due to Covid-19. The converted audio tracks (the video tracks were deleted) were transferred to preliminary transcripts via f4x voice recognition and edited by a student assistant. The transcripts were analyzed with a structured qualitative content analysis.
The video-vignette shows a lesson in primary science education with the topic 'solubility' in 4th grade (students are about ten years old). The science teacher prepared an inquiry-based lesson with scaffolding on level 1 (structured inquiry; Abels & Lembens, 2015; Blanchard et al., 2010), i.e., the teacher decides about the research question and the choice of methods, but the students hypothesize and experiment in small groups and think of an interpretation of the results. The vignette is divided in an (1) engage-, (2) explore- and (3) explain-phase (Bybee et al., 2006): In the first phase, the teacher presents a problem to the students, using story-telling, that her daughter hid something in a jar with a clear liquid. The students should answer the research question: What is "hidden", i.e., dissolved in the water? In the second phase, a student group experimenting is shown, trying to investigate their own hypotheses in mixing different ingredients with water (e.g., vinegar, ketchup, oil, salt and sugar). In the last phase, the students present and discuss their results with the teacher developing follow-up questions.

3.2 Structured Qualitative Content Analysis with the ACM

For the structured qualitative content analysis (Kuckartz, 2016) we transformed our theoretical model, the ACM, into a deductive category scheme to analyze the VSRef of the expert group. We operationalized the synthesized stages (chapter 2.3) into different codes (Tab. 2). On the left column, there are the taxonomic stages from unistructural to extended abstract referring to the skill development specified by the SOLO Taxonomy. Each stage is complemented by subcodes from the other models (Tab. 1 and Tab. 2 further below).

Tab. 1. Cut-out of the category system (stage 1).

Main Category	Subcode
1 Unistructural – Identifying and naming one relevant aspect	1.1 Verbalizing common places
	1.2 Verbalizing naïve perceptions of teaching
	1.3 Verbalizing naïve perceptions of inclusion
	1.4 Reproducing central terms
	1.5 Reproducing out of context rules
	1.6 Following learnt rules and practices
	1.7 Referring to personal experiences
	1.8 Selecting isolated and visible (teaching) events

Other codes like describing, evaluating, interpreting and generating alternatives on action do not belong to any stage, but they are needed as a first classification of the transcript passages as the study participants may not follow the task, i.e., when asked to describe they may evaluate or already interpret. Furthermore, the passages coded with the category 'describing' are not part of further analysis, while passages in the other three categories are relevant to investigate analytical competencies. Mere describing does not show an investigable performance of analytical competency, as we wanted to know what the study participants identified as inclusive science education in the video-vignette and how they reason their selections. To identify the text passages for analysis, we divided the transcripts into syntactic coding units[2] and classified them as description, evaluation, interpretation or generating alternatives on action. On the right column of Table 2, the subcodes are listed for every stage that illustrate the analytical competencies of the study participants derived from the other models (chapter 2.4). Coding the units of the transcripts first by the stages of the SOLO Taxonomy, only the subcodes of the chosen stage can be used for the same transcript passage, i.e., coding unit. For example, if an expert identified inclusive science education on the surface without connecting it to further concepts, we used the code of relational A. Then we only used subcodes within the relational A stage, analyzing the transcript passage further.
To give a more detailed example, we chose a short passage coded in stage 1 to illustrate the different coding steps of the coding process. In chapter 4, the results will be presented and chapter 5 presents a thorough discussion of the results.
Syntactical unit: "Perhaps it would be good to write it [the results of the students] on the black board. Uhm, and that the students note it for themselves, too. That does not happen in this situation."[3] (20201124_MC39H_VSRef_Exp, Pos. 75)
Coding steps:

(1) Identify the step in analyzing the video scene (Schwindt, 2008; Sherin & van Es, 2009): Generating alternatives on action
(2) Identify the "field of knowledge": General pedagogy
(3) Identify the taxonomic stage (Biggs & Collis, 1982): Unistructural (chosen because one aspect is addressed)
(4) Identify the subcodes immanent to the stage: 1.6 Following learnt rules and practices and 1.8 Selecting isolated and visible (teaching) events (Tab. 1)

Explanation: The study participant describes a situation in which the teacher neither writes the results of the experiment on the blackboard nor gives the students instructions to write down the results to have a backup for following lessons on this topic. For the participant it seems important to save findings, so the alternative suggested is to note the findings. Having a lesson phase of saving results is attributed to general pedagogy. As the participant does not connect the teaching event to other situations, theories or fields of knowledge like inclusive or science education, the coding 'unistructural' was chosen. Additionally, the study participant describes an isolated teaching event and follows the learnt rule, that results from the lesson should be saved (subcodes 1.6 and 1.8).

3.3 Expert Validity and Intercoder Reliability

For the validation of our ACM, we have chosen two components, which are mutually dependent: expert validity and dialogical validation (Lamnek, 2010). The ACM and its application as category scheme were discussed several times with experts from the scientific community in monthly research workshops, at national and international presentations

[2] Syntactical units are sequences of the transcripts, showing complete statements on one coherent topic, from minimum one sentence to one paragraph maximum. They are used to facilitate coding.
[3] Quotes were in German and translated from the first author as close as possible to the original wording.

and two doctoral student colloquia. For Lamnek (2010) the expert validity alone is not sufficient for objectivity and reliability, so the ACM was further revised by means of intercoder reliability, i.e., a second researcher analyzed 20 % of the data. Variations were discussed to achieve further consensus. The results of the discussions were included in the development process of the ACM. All results were calculated and analyzed with MAXQDA 2020 software.

4 Results

In this chapter, the results of the content analysis are presented to answer the research question, which analytical competencies the experts perform in a video-stimulated reflection regarding inclusive science education.
Statements of the experts were coded at different stages of the ACM. The codings per stage are unequally distributed. In total, the stages were coded 202 times: stage 0 was coded 8 times, stage 1 91, stage 2 10, stage 3 68, stage 4 17 and stage 5 8 times.

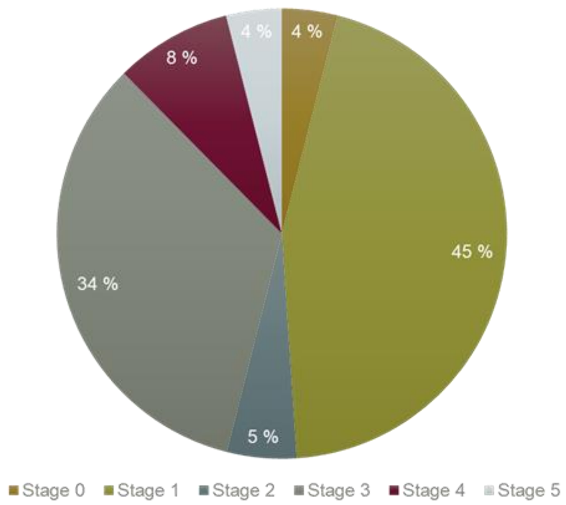

Fig. 2. Coding frequency of the stages (relative frequency).

The experts identified many aspects of inclusive science education (Fig. 3). Whenever inclusive science education was identified, stage 3, 4 and 5 and its subcodes were applied.

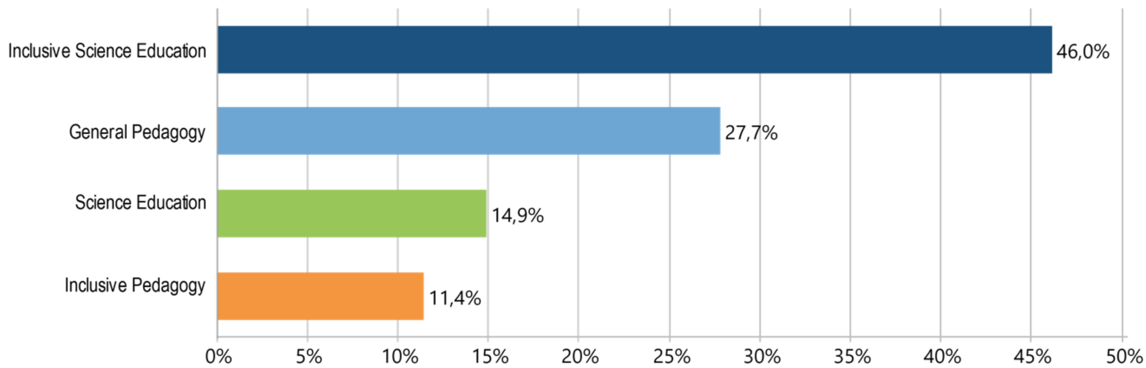

Fig. 3. Coded fields of knowledge.

The percentage of stage 1 is the highest (45 %), it is followed by stage 3 (34 %). From this stage on, the identification of inclusive science education is coded. Stage 4 and 5 are also coded, but not with a high proportionate percentage. In four of the six experts' transcripts stage 5 was coded. In two transcripts, stage 5 was not coded at all. Codes of stage 4 were used in all transcripts. The distribution of codes will be discussed in chapter 5.
The first overview of the main categories is now followed by a deeper insight into the complete ACM category scheme – approaches, fields of knowledge and the subcodes – to investigate more detailed which codes were used to categorize the experts' performance. The coding steps were already described in chapter 3.2. Table 2 summarizes all codings. In the left column, the first two categories are approaches and fields of knowledge, as the two categories were used for structuring the transcript. The two categories are followed by the main categories of the ACM with a brief definition of the stages. In the middle column, the subcodes are listed per stage. In the two right columns, the code frequency

and (relative) frequency in percent are illustrated. Beneath the different sections, a total score of code frequency and percentage was calculated. The table is also constructed as a color matrix with a color key that shows the frequency of the subcodes at one sight. The range is oriented towards the relative frequency of the distributed codings.
Noticeably, subcodes 1.8 (24.4 %) and 3.1c (14.9 %) show a higher code frequency than other subcodes. Stage 2 has the lowest proportionate distribution, stage 3 the highest (Tab. 2).
To have a closer insight into the experts' performance, two examples from stage 3 and 5 are presented (Tab. 3). Both examples were coded as the analytical step 'interpretation' and 'inclusive science education' as "field of knowledge". The experts analyzed the same selected scene: the engage phase in which the teacher offers different symbols or pictographs to the students, which they had to put on the blackboard, and try to form first hypotheses.
Both experts focused on the visualization as an inclusive element in a science lesson. They not only selected and analyzed isolated scenes like novices tend to do (Berliner, 2004; Schwindt, 2008), the experts attributed the visualizations to the whole lesson. In example 1, inquiry-based learning and the forming of research hypotheses were identified, but not further connected or deepened with concepts or underlying theories. In example 2, the use of symbols is related to the underlying concept of the iconic level of representation (Bruner, 1964). Iconic symbols are recognized as structuring the working process of hypothesizing and experimenting.
Both experts analyzed the same sequence at different stages. The analysis with the ACM makes it possible to illustrate the different performances.
The intercoder reliability of the category scheme (Tab. 2) is 65,26 % (310 accordances and 165 non-accordances with 90 % segment overlap), results in Brennan and Prediger's Kappa (1981) of 0.64 (substantial compliance). 30 % of the material was coded from a student assistant after instructions from the researcher.

RANGE in %	
>= 21	
<= 20	
<= 10	
<= 5	

Tab. 2. Deductive category scheme of the ASC (colour matrix).

Approaches	Code Frequency	%
Describing	97	32.8
Evaluating	47	15.9
Interpreting	118	39.9
Generating alternatives on action	34	11.5
TOTAL	**296**	**100**
Fields of Knowledge		
General Pedagogy	56	27.7
Science Education	30	14.9
Inclusive Pedagogy	23	11.4
Inclusive Science Education	93	46.0
TOTAL	**202**	**100**

Main Category	Subcode	Code Frequency
0 Prestructural – Incompetent, misses point (8)	0.1 Wrong content	2
	0.2 No differentiation between important and unimportant (teaching) events	3
	0.3 Reasoning is not understandable	3
1 Unistructural – Identifying and naming one relevant aspect (91)	1.1 Verbalizing common places	19
	1.2 Verbalizing naïve perceptions of teaching	1
	1.3 Verbalizing naïve perceptions of inclusion	0
	1.4 Reproducing central terms	20
	1.5 Reproducing out of context rules	1
	1.6 Following learnt rules and practices	11
	1.7 Referring to personal experiences	0
	1.8 Selecting isolated and visible (teaching) events	74
2 Multistructural – Identifying, describing, listing or enumerating (unconnected) events and relevant aspects (10)	2.1a Verbalizing personal experiences (episodic and case-based knowledge)	0
	2.1b Verbalizing uncertainty about the teacher's action	3
	2.1c Realizing similarities between selected events	0
	2.2a Referring to knowledge of practice	0
	2.2b Reflecting experiences in practice and applying them usefully	0

	2.3a Using strategic and conditional knowledge for reasoning	4
	2.3b Reasoning degree of conformity to rules	0
	2.4 Summarizing isolated events in superordinated concepts and presenting them in everyday language	3
3 Relational A – Identifying inclusive science education superficially (68)	3.1a Making decisions in inclusive science education and reflecting them superficially	10
	3.1b Setting priorities in inclusive science education and reflecting teaching	9
	3.1c Explaining ways for reaching goals in inclusive science lessons	45
	3.2 Differentiating between important and unimportant (teaching) events	3
	3.3a Integrating the curriculum, the concrete teaching context into the reflexion	1
	3.3b Integrating special characteristics of students into the reflexion	3
	3.3c Controlling (teaching) events in inclusive science education and reflecting them superficially	1
	3.4 Reflecting inclusive science education superficially, slowly and reluctantly	6
	3.5 Identifying isolated (teaching) events or actions and their effects and connecting them to larger syntactic units	3
	3.6 Identifying and predicting consequences on action	16
	3.7 Selecting a(n) (teaching) event and classifying it theoretically along terms of inclusive science education	9
	3.8 Identifying critical (teaching) events in context of inclusive science education and verbalizing them	4
4 Relational B – Analysing, applying, discussing, comparing/contrasting, criticizing, explaining, relating and reasoning in detail and factual correct (on the basis of concepts) inclusive science education (17)	4.1a Noticing and explaining (teaching) events in inclusive science education globally	0
	4.1b Identifying and explaining similarities of (teaching) events in inclusive science education	0
	4.2a Making precise predictions in context to inclusive science education	0
	4.2b Making predictions about disturbing behaviour, boredom, confusion or curiosity of students in inclusive science education	8
	4.2c Using case knowledge to meet or predict problems	0
	4.3 Utilizing case knowledge to meet/solve or predict problems	5
	4.4 Making analytical and deliberate decisions in inclusive science education and verbalizing them	7
	4.5 Selecting a(n) (teaching) event and analysing it independently from inclusive science education contexts	1
	4.6 Focused answering of questions through summarizing isolated (teaching) events from inclusive science education	1
	4.7 Summarizing isolated (teaching) events from inclusive science education in concepts	7
	4.8 Noticing critical (teaching) events in inclusive science education and pointing out possible consequences of behaviour	3
5 Extended Abstract – Generalizing to new domain, creating, formulating, generating, hypothesizing, reflecting, theorizing inclusive science education (8)	5.1 Reflecting logically on content level of inclusive science education	6
	5.2 Reflecting automatic and experienced acting in inclusive science education	0
	5.3 Referring to analytical processes for reflecting of unusual (teaching) events in inclusive science education	1
	5.4 Naming explicitly precise reasons for the (bad) quality of the entire teaching process in inclusive science education and generating alternatives for the entire process	0
	5.5 Assessing the importance of didactical-methodological syntactic units of the entire teaching process of inclusive science education and generating justifiable alternatives for these units	2

	5.6 Selecting a(n) (teaching) event for describing, reasoning, evaluating and connecting it to theories of inclusive science education and proposing a solution	1
	5.7 Filtering and verbalizing isolated (teaching) events and connecting them in order to answer a targeted question	2
	5.8 Summarizing isolated (teaching) events in superordinate concepts and categorizing theories of teaching and learning in the context of inclusive science education	5

Tab. 3. Coding examples with the coded stages and subcodes.

Example 1	Example 2
"(…) it can be noticed, that the teacher, uhm, tries to give the students some structure with those symbols. Accordingly, to the inquiry-based learning itself, and for the development of the [research] question and, uhm, later on to the hypotheses.". (20201221_AH91M_VSRef_Exp, Pos. 36)	*"Uhm, I would (…) interpret it that way, that the children (…) solve the matching exercise above all with the symbols. That means that they can on the one hand, structure the working process for themselves iconic practically, or rather (…) this process of hypothesizing, maybe forming hypotheses what here then maybe indicates (…) the next step of experimenting, testing."* (20201211_GP80H_VSRef_Exp, Pos. 46)
Relational A *3.2 Differentiating between important and unimportant (teaching) events* *3.7 Selecting a(n) (teaching) event and classifying it theoretically along terms of inclusive science education.*	**Extended Abstract** *5.1 Reflecting logically on content level of inclusive science education* *5.8 Summarizing isolated (teaching) events in superordinate concepts and categorizing theories of teaching and learning in the context of inclusive science education*

5 Discussion and conclusion

With the categories of the ACM we try to capture the analysis of classroom videos and how student teachers work with the perspectives of science education, inclusive education and the connection of both (chapter 2.1). The analytical steps of describing, evaluating, interpreting and generating alternatives on action of inclusive science education in classroom situations is a complex process, which we categorized and summarized.

The results of analyzing the experts' VSRefs show both expected and unexpected results. We were eager to see according to which stages of the ACM the experts' analyses could be coded. Four of six study participants analyzed some aspects of the video-vignette at stage 5 as they connected the selected scenes with concepts and theories regarding inclusive science education and had a wide focus in their analyses and their interpretation (variety of subcodes). Additionally, they discussed appropriate alternatives on action to create a more inclusive setting, enabling participation and access for all students in the presented science lesson.

An unexpected result was the low percentage of codings at stage 4 and 5 and that in two transcripts stage 5 was not coded at all. Possible explanations could be like follows: (1) The experts had no preparation course for professional vision and inclusive science education (like the pre-service teachers had in their seminar). The experts had to refer to their background knowledge spontaneously and had only five minutes for arranging and complementing their notes after the vignette presentation before the beginning of the reflection. Maybe more preparation time before and during the VSRef could lead to more codings in stage 4 and 5. (2) The VSRefs consist of spontaneous verbal statements. Perhaps a written analysis with a long preparation time could result in a higher percentage of codings on the proficient and expert stage (cf. Hatton & Smith, 1995). (3) The experts' sample consists of PhD students and postdocs. Maybe the VSRefs could be repeated with professors who show more experience and expertise in the field of inclusive science education and may target the expert stage more frequently than the present sample. However, research in the field of inclusive science education is rather new so that we expected PhDs and postdocs to be most up to date.

Another unexpected result was the high rate of codings at stage 1. If we summarize codings at stages 3-5, the result is 46.0 % in relation to 54.0 % of the lower stages (0-2). There are two possible explanations for the high percentage at stage 1. When the experts were asked to describe the selected scene at first, they did not remain at a mere description, but they already interpreted, thus the statements were considered for analysis. We expect this to be different for the pre-service teachers as they practice to merely describe. During the task to describe, mostly aspects of general pedagogy were coded. General pedagogy and stage 1 have a coding overlap of 47 %. These first interpretations were probably not meant by the experts to be elaborated further as they intended to describe the scenes, but because of their expert knowledge, they already used theoretical classifications.

At stage 1, the subcode 1.8, which was used if there was an isolated teaching event selected, was coded very often. This was mainly the case when the experts were instructed to describe the selected scene, but already made the step further to interpret it. When they were instructed to interpret, they normally did not analyze isolated scenes like novices do (Plöger & Scholl, 2014; Schwindt, 2008), they mostly verbalized a holistic view of the science lesson (e.g. 3.5, 4.7 and 5.8; see Tab. 2) and/or predicted behavior of teacher and/or students (e.g. 4.2b and 4.3; see Tab 2). A problem could be that the subcode 1.8 is very close to the definition of the main category, i.e., when stage 1 is chosen, subcode 1.8 applies. It has to be discussed whether the subcode is dispensable. We will see if the code is needed for the pre-service teachers, as novices tend to concentrate on isolated events.

Subcode 3.1c is the subcode with the second highest percentage. It was applied if a study participant explained ways to reach goals in inclusive science education. One possible explanation could be that the subcode is not specified enough, another one that the experts think very goal-oriented when analyzing teaching. As Fischer, Boone and Neumann (2014, p. 18) state, "[t]he main aim of science education research is to improve science learning." A related explanation is the connection to the analytical step 'alternatives on action' at this stage (Tab. 2). 27.4 % are a double coding of alternatives on action and subcode 3.1c. Instead of just coding that a goal was to be achieved, inductive codes or deductive codes of the Framework for Inclusive Science Education (Brauns & Abels, 2021b) could be added to get a hold of what was suggested, because there are several ways to reach goals in a science lesson. The definition of goals should be more specified in the ACM.

The last unexpected result is the low variety of subcodes at stage 2. Only three of eight subcodes were used in the analyses of the VSRefs. Two or more aspects of the fields of knowledge are addressed unconnectedly at this stage. One explanation could be, that most of the experts could not refer to personal practical experience in teaching science – subcategories 2.1a, 2.1c, 2.2a and 2.2b require practical experiences. Another explanation could be, that experts reflect more on a meta level and do not integrate their personal experience as a reference point. Maybe in-service teachers would link their practical experience more to the content of the video-vignette compared to experts of science education research. Same counts for pre-service teachers after their long-term practical experience during their Master studies.

To come to a final conclusion concerning the analytical competency of the experts, two interpretations are possible. Either, we see the experts showing analytical competencies on a high level regarding inclusive science education, as they are able to make statements coded with stage 4 and/or 5 (qualitative conclusion). Alternatively, we see the experts showing analytical competencies on a middle level (stage 3 was coded most often) providing a possible explanation why stage 1 was coded so often (quantitative conclusion). The experts verbalized their holistic view on the science lesson and connected it to concepts of inclusive science teaching. The data analysis of this study on the analytical competency of experts confirms what was already investigated in other studies of teachers' expertise and their professional vision (Seidel & Prenzel, 2007; Schwindt, 2008; Plöger & Scholl, 2014; Sherin; Krepf, 2019). The experts analyzed the video vignette in accordance to the findings of research in this field (2.1, 2.2). Regarding this comparison to other studies, we tend to draw the qualitative conclusion assessing the analytical competencies on a high level (stage 4 and/or 5).

A final conclusion regarding the ACM is the revision of categories that appear to be too general and to add more inductive subcodes to the different stages. These subcodes will illustrate the stages more specifically regarding inclusive science education. Additionally, we work on the categorization of further data on the pre-service teachers' competencies. Considering all the collected data (reflections of their own and other's teaching and questionnaires), a holistic view of every individual study participant's analytical competency development over two semesters in the project seminar can be gained.

The ACM is a contribution to the explorative research of inclusive science education and the professional development of pre-service teachers in higher education. The research field of inclusive science education in the context of professional development is of high relevance to implement a barrier-free and participative science education in schools. The way to bring scientific literacy to all learners begins with the education of science teachers.

6 Implications

With the ACM we developed a tool to investigate analytical competency of pre-service teachers in the context of inclusive science education. Analyzing the VSRefs of experts in the field of inclusive science education creates and prepares reference points for the analysis and evaluation of the pre-service teacher sample. The performance of VSRefs with an expert sample and its analysis, help to revise the ACM, to make it more precise with the aim to investigate other samples. Coding reflection processes with the ACM enables a comparison between groups on different levels of expertise regarding inclusive science education. The results can be used to provide an adaptive professional development taking the analytical competency of pre-service teachers into account when confronting them with video vignettes. We imagine the ACM to be a diagnostic tool in higher education.

We further point out that experts in the relatively new field of inclusive science education already exist. They represent a key role in the research in and the development of inclusive science education from all science disciplines at primary and secondary level. There is a need for well-prepared future teachers, who are able to prepare, teach and reflect inclusive science lessons as enabling participation and creating access leads to the possibility of gaining scientific literacy for all students. Scientific literacy is a prerequisite for an active participation in societal processes in a hyper-technological environment and inclusive science education could provide real opportunities to prepare students for a responsible citizenship.

Acknowledgement

The federal ministry of education and research (funding number: 01NV1731) funded this work. The authors thank the experts participating in our study, the student assistants who transcribed the VSRefs and the second researcher validating the codings.

References

Abels, S., & Schütz, S. (2016). Fachdidaktik trifft Inklusive Pädagogik – (Unausgeschöpfte) Potentiale in der Lehrerbildung. *Zeitschrift für Heilpädagogik*, *67*(9), 425–436.

Abels, S. & Lembens, A. (2015). Mysteries als Einstieg ins Forschende Lernen im Chemieunterricht. *Chemie & Schule, 30*(1b), 3–5.

Ainscow, M. (2007). Taking an inclusive turn. *Journal of Research in Special Educational Needs, 7*(1), 3–7.

Berliner, D. C. (1987). In pursuit of the expert pedagogue. *Educational Researcher, 15,* 5–13.

Berliner, D. C. (1991). Perceptions of student behavior as a function of expertise. *Journal of Classroom Interaction 26*, 1-8.

Berliner, D. C. (1994a). Expertise: The wonders of exemplary performance. In J. N. Mangieri & C. C. Block (Eds.), *Creating powerful thinking in teachers and students* (pp. 141–186). Holt, Rinehart & Winston.

Berliner, D. C. (1994b). Teacher expertise. In T. Husèn & T. Neville Postlethwaite (Eds.), *The international encyclopedia of education* (2nd ed., Vol. 10, pp. 6020–6026). Pergamon.

Berliner, D. C. (2001). Learning about and learning from expert teachers. *International Journal of Educational Research 35*(5), 463–482.

Berliner, D. C. (2004): Describing the behaviour and documenting the accomplishments of expert teachers. *Bulletin of Science, Technology & Society, 24,* 200–212.

Biggs, J. & Collis, K. (1982a*). Evaluating the quality of learning: The SOLO taxonomy.* Academic Press.

Biggs, J. & Collis, K. (1982b). *SOLO-Taxonomy.* Retrieved from https://www.johnbiggs.com.au/academic/solo-taxonomy/ (access: 30/05/2020)

Blanchard, M. R., Southerland, S. A., Osborne, J. W., Sampson, V. D., Annetta, L. A. & Granger, E. M. (2010). Is Inquiry Possible in Light of Accountability?: A Quantitative Comparison of the Relative Effectiveness of Guided Inquiry and Verification Laboratory Instruction. *Science Education, 94*(4), 577–616.

Booth, T. (2003). Inclusion and exclusion in the city: concepts and contexts. In P. Potts (Ed.), *Inclusion in the City: Selection, schooling and community* (pp. 1–14). Routledge Falmer.

Brauns, S. & Abels, S. (2021a). The Framework for Inclusive Science Education (Inclusive Science Education 1/2020 (2nd ed.). Leuphana University Lüneburg, Science Education. www.leuphana.de/inclusive-science-education

Brauns, S. & Abels, S. (2021b). Videoanalyse mit dem Kategoriensystem inklusiver naturwissenschaftlicher Unterricht (KinU). *Progress in Science Education, 4*(2), 71–84. https://doi.org/10.25321/PRISE.2021.1146

Brennan, R. L., & Prediger, D. J. (1981). Coefficient kappa: Some uses, misuses, and alternatives. *Educational and Psychological Measurement, 41*(3), 687–699.

Bruner, J. S. (1964). The course of cognitive growth. *American Psychologist, 19*(1), 1–15.

Bybee, R. W., Taylor, J. A., Gardner, A., van Scotter, P., Carlson Powell, J., Westbrook, A., & Landes, N. (2006). *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications.* BSCS.

Bybee, R. W. (1997a). Toward an understanding of scientific literacy. In W. Gräber & C. Bolte (Ed.), *Scientific literacy: An international symposium* (pp. 37–69). Kiel: IPN-Leibniz Institute for Science and Mathematics Education.

Bybee, R. W. (1997b). *Achieving scientific literacy: From purpose to practices.* Heinemann.

Carter, K., Cushing, K., Sabers, D., Stein, P., & Berliner, D. C. (1988). Expert-Novice differences in perceiving and processing visual classrom information. *Journal of Teacher Education, 39*, 25–31.

Dreyfus, H. L. & Dreyfus, S. E. (1986*). Mind over machine.* Free Press.

Egger, D., Brauns, S., Sellin, K., Barth, M., & Abels, S. (2019). Professionalisierung von Lehramtsstudierenden für inklusiven naturwissenschaftlichen Unterricht. *Journal für Psychologie*, *27*(2),50–70.

Ferreira González, L., Führer, L., Sührig, L., Weck, H., Weirauch, K. & Abels, S. (2021). Ein Unterstützungsraster zur Planung und Reflexion inklusiven naturwissenschaftlichen Unterrichts. In S. Hundertmark, X. Sun, S. Abels, A. Nehring, R. Schildknecht, V. Seremet & C. Lindmeier (Hrsg.), *Naturwissenschaftsdidaktik und Inklusion, 4. Beiheft Sonderpädagogische Förderung heute* (pp. 191–215). Beltz Juventa.

Fischer, H. E., Boone, W. J., & Neumann, K. (2014). Quantitative Research Designs and Approaches. In Lederman N. G. & Abell S. K., *Handbook of Research on Science Education*. Routledge.

Florian, L. & Black-Hawkins, K. (2011). Exploring inclusive pedagogy. *British Educational Research Journal, 37*(5), 813–828.

Florian, L., & Spratt, J. (2013). Enacting inclusion: a framework for interrogating inclusive practice. *European Journal of Special Needs Education, 28*, 119–135.

Gräber, W. & Nentwig, P. (2002). Scientific Literacy – Naturwissenschaftliche Grundbildung in der Diskussion. In W. Gräber, P. Nentwig, T. Koballa, & R. Evans (Eds.), *Scientific Literacy - Der Beitrag der Naturwissenschaften zur Allgemeinen Bildung* (pp. 7–20). Leske und Budrich.

Hatton, N. & Smith, D. (1995). Reflection in teacher education: Towards definition and implementation. *Teaching and Teacher Education, 11*(1), 33–49.

Korthagen, F. A. J. (2010). How teacher education can make a difference. *Journal of Education for Teaching, 36*(4), 407–423.

Krepf, M. (2019). *Wie analysieren ExpertInnen und NovizInnen Unterricht?* Klinkhardt.

Kuckartz, U. (2016). *Qualitative Text Analysis. Methods, Practice, Computer Assistance.* Sage Publications.

Kunter, M., Baumert, J., Blum, W., Klusmann, U., Krauss, S., & Neubrand, M. (2013). *Cognitive Activation in the Mathematics Classroom and Professional Competency of Teachers.* Springer.

Lamnek, S. & Krell, C. (2010). *Qualitative Sozialforschung: Lehrbuch. Grundlagen Psychologie.* Beltz.

Menthe, J. & Hoffmann, T. (2015): Inklusiver Chemieunterricht: Chance und Herausforderung. In Musenberg, O. & Riegert, J., (Eds.), *Inklusiver Fachunterricht in der Sekundarstufe* (pp. 131–141). W. Kohlhammer.

Mumba, F., Banda, A., & Chabalengula, V. M. (2015). Chemistry Teachers' Perceived Benefits and Challenges of Inquiry-Based Instruction in Inclusive Chemistry Classrooms. *Science Education International, 26*(2), 180–194.

Munby, H., Russell, T., & Martin, A. K. (2002). Teacher's knowledge and how it develops. In V. Richardson (Ed.), *Handbook of research on teaching* (pp. 877–904). American Educational Research Association.

Nehring, A., & Walkowiak, M. (2017). Eine inklusive Lernumgebung ist nicht genug: Fachspezifik, Theoretisierung und inklusive Unterrichtsentwicklung in den Naturwissenschaftsdidaktiken. *Zeitschrift für Inklusion*. Retrieved from https://www.inklusion-online.net/index.php/inklusion-online/article/view/450 (access: 15/05/2021).

Palmer, D. J., Stough, L. M., Burdenski, T. K., & Conzales, M. (2005). Identifying teacher expertise: An examination of researchers' decision making. *Educational Psychologist, 40*(1), 13–25.

Plöger, W. & Scholl, D. (2014). Analysekompetenz von Lehrpersonen – Modellierung und Messung. *Zeitschrift für Erziehungswissenschaft, 17*(1), 85–112.

Potvin, P. & Hasni, A. (2014). Analysis of the Decline in Interest Towards School Science and Technology from Grades 5 Through 11. *Journal of Science Education and Technology, 23*(6), 784–802.

Santagata, R. & *Guarino,* J. (2011). Using video to teach future teachers to learn from teaching. *ZDM Mathematics Education 43*, 133–145.

Sawalies, J., Veber, M., Rott, D., & Fischer, C. (2013). Inklusionspädagogik in der ersten Phase der Lehrerbildung. Eine explorative Studie zu Stand und Unterschieden universitärer Lehrangebote für die Regelschullehrämter. *Schulpädagogik heute, 4*(8), 1–17.

Schön, D. (1983). *The Reflective Practitioner: How Professionals Think in Action.* Basic Books.

Schwindt, K. (2008). *Lehrpersonen betrachten Unterricht. Kriterien für die kompetente Unterrichtswahrnehmung.* Waxmann.

Scruggs, T. E., Mastropieri, M. A., Berkeley, S., & Graetz, J. E. (2010). Do Special Education Interventions Improve Learning of Secondary Content? A Meta-Analysis. *Remedial and Special Education, 31*(6), 437–449.

Scruggs, T. E., Mastropieri, M. A., & Okolo, C. M. (2008). Science and social studies for students with disabilities. *Focus on Exeptional Children, 41,* 1–24.

Seidel, T., Stürmer, K., Blomberg, G., Kobarg, M., & Schwindt, K. (2011). Teacher learning from analysis of videotaped classroom situations: Does it make a difference whether teachers observe their own teaching or that of others? *Teaching and Teacher Education, 27*(2), 259–267.

Seidel, T., & Prenzel, M. (2007). Wie Lehrpersonen Unterricht wahrnehmen und einschätzen - Erfassung pädagogisch-psychologischer Kompetenzen bei Lehrpersonen mit Hilfe von Videosequenzen. *Zeitschrift für Erziehungswissenschaft, Sonderheft 8,* 201–216.

Sherin, M. G., & Van Es, E. A. (2009). Effects of video club participation on teachers' professional vision. *Journal of Teacher Education*, *60*(1), 20-37.

Sherin, M. G., Russ, R. S., Sherin, B. L., & Colestock, A. (2008). Professional Vision in Action: An Exploratory Study. *Issues in Teacher Education 17*(2), 27–46.

Sherin, M. G. (2007). The development of teachers' professional vision in video clubs. In R. Goldman, R. Pea, B. Barron & S. J. Derry (Eds.), *Video research in the learning sciences* (pp. 383–395). Erlbaum.

Sherin, M.G. (2001). Developing a Professional Vision of classroom events. In T. Wood, B.S. Nelson & J. Warfield (Eds.), *Beyond classical Pedagogy* (pp. 75–93). Lawrence Erlbaum.

Shulman, L. S. (2004). *The wisdom of practice: Essays on teaching, learning, and learning to teach.* Jossey-Bass.

Stinken-Rösner, L., Abels, S., Hundertmark, S., Menthe, J., Nehring, A. & Rott, L. (2021). Naturwissenschaftlicher Unterricht und Lehrerbildung im Umbruch?: Online Jahrestagung 2020 der Gesellschaft für Didaktik der Chemie und Physik. In S. Habig (Ed.*), Gesellschaft für Didaktik der Chemie und Physik (GDCP); Band 41* (pp. 169-172). Universität Duisburg-Essen.

Stinken-Rösner, L., Rott, L., Hundertmark, S., Baumann, T., Menthe, J., Hoffmann, T., Nehring, A. & Abels, S. (2020). Thinking Inclusive Science Education from two Perspectives: Inclusive Pedagogy and Science Education. *RISTAL, 3*, 30–45.

Stürmer, K., Seidel, T., & Schäfer, S. (2013). Changes in professional vision in the context of practice. *Gruppendyn Organisationsbeirat, 44*(3), 339–355.

Therrien, W.J., Taylor, J. C., John L. Hosp, J. L., Kaldenberg, E. R., & Gorsh, J. (2011). Science Instruction for Students with Learning Disabilities: A Meta-Analysis. *Learning Disabilities Research & Practice 26*(4), 188–203.

UNESCO (2018). Brussels Declaration. Global Education Meeting 2018. Retrieved from: https://en.unesco.org/sites/default/files/2018-12-07_brussels_declaration.pdf (access: 18/01/2021).

Villanueva, M. G., Taylor, J., Therrien, W., & Hand, B. (2012). Science education for students with special needs. *Studies in Science Education, 48*(3), 187–215.

Voss, T., Kunina-Habenicht, O., Hoehne, V., & Kunter, M. (2015). Stichwort Pädagogisches Wissen von Lehrkräften: Empirische Zugänge und Befunde. *Zeitschrift für Erziehungswissenschaft, 18*(2), 187–223.