Adaptation of the DECoSTE Observation Tool in a chemistry education course

Matthias Stadler

Bergen University

This document is based on the work in the project *Designing and Enacting Coherent Science Teacher Education – DECoSTE*. The project was funded by Erasmus+, Grant Agreement No. 2020-1-DE03-KA201-077542.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Table of Contents

Introduction and setting

The following text describes the implementation of the DECoSTE Observation Tool (DOT) in a course for future chemistry teachers at the University of Bergen (UiB) and experiences made. It is meant to show the flexibility of the instrument that allows it to be tailored to different courses and course plans in a teacher education programme with the goal of supporting coherence and learning.

The text has two parts. First, I describe the implementation of the DOT as a tool to learn about and from observation (called reflection for action in the booklet on the DOT). Second, I describe the use of the DOT to produce observational data as a starting point for reflective discussions about the quality of lessons conducted by PSTs in their school practice (reflection on action).

The course is about chemistry education (Didaktik in the European tradition) and is a mandatory in the fourth year of the teacher education programme at the Faculty of Mathematics and Science. The programme is preparing for teaching in mathematics and the sciences in grades 8-13 with a focus on the upper grades. The course has 15 ECTS and consists of 40 lessons of 45 minutes each distributed over one year. Besides the course, pre-service teachers (PSTs; the term student is used for addressing students in school) have two periods of school practice (appr. 70 days). The content of the course can be adapted to some degree, but must follow instructional aims, topics and literature in the course description.

Learning to teach from observing teaching

The PSTs observed 5 days of teaching in each of the three years of their study programme before taking the course. These observations are partly focused on certain instructional activities (i.e., teacher-student dialogue, student dialogue in groups, or practical activities). There is the possibility for systematic observations of whole lessons (i.e., structure or student activation), but without assignments and organized reflection this is unlikely to happen. PSTS' feedback on this practice is often that it is too much observation. In the fourth year, a part of the PSTs whishes for more opportunities to observe diverse teaching practice.

The DOT was seen as an opportunity for the PSTs to learn about systematic observation and at the same time provide ideas for observations that could benefit PSTs' learning to teach both in course work at the university and in coming practice in school. In addition, the DOT was regarded as useful to provide a starting point for reflective discussions of a PST's own lessons.

Aims of Using DOT

The design of the application of the DOT aimed at showing that observation includes interpretation leading different people observing the same activity to different results. A second aim was to show that many different aspects of a lesson could be observed and that an observer must decide on what to focus. A third goal was to show that different lessons yield different activity patterns and that these patterns can tell something about what was happening and the quality of the lessons.

Implementing DOT

In the second two-lesson session of the course, a mandatory analysis of a chemistry lesson was announced. The PSTs got six days to submit the completed assignment before it was discussed in the following session. Each PST had to observe a lesson and use the DOT to code different activities. The code graph was submitted to the lecturer together with a brief written account of interesting observations from the lesson and a characterization of its main features.

PSTs were assigned to five different groups (3-4 PSTs each). Each group was assigned a certain video to watch and a set of codes to apply (table 1). The videos were three lessons from TIMSS video 1999 that showed distinctive features. All three lessons included whole class talk and practical work in groups.

Group	Video	Codes
1	1	DECoSTE
2	1	Norwegian class
3	1	Inquiry
4	2	Inquiry
5	3	Inquiry

Table 1. Video and codes assigned to the five groups of PSTs.

The PSTs used three different sets of codes. One set called the DECoSTE codes were those agreed on by our project. Most of these codes were high-inference codes that required to follow an activity for some time before the code could be decided on (i.e., teacher highlights multiple ideas) or were of very short duration (i.e., students ask questions). This is unproblematic when coding videos with commercial software for qualitative analysis, but it can be challenging in a live setting as implemented in the DOT.

Therefore, two more code sets were developed (table 2). The second set was called “Norwegian class” and included typical activities that were expected for a Norwegian science lesson. A third set was called “inquiry” and included codes that could be linked to inquiry classrooms. The PSTs got the codes in Norwegian, and the codes were not discussed before PSTs used them for coding their lesson.

Norwegian Class		Inquiry	
The teacher …	The students …	The teacher …	The students …
introduces new	work with	talks to whole class	discuss possible
shows example tasks	talk in groups	talks to student or	share observations in
circles classroom	take notes	gives instructions	share possible explanations in class
activates student knowledge	listen to teacher	asks students to elaborate	develop models
summarises student results	do experiments	shows something practical	develop experiments

Table 2. Code sets developed for the assignment.

Results of the coding were discussed in the fourth session of the course. PSTs were asked for the usability of the tool and the code sets before selected pairs of graphs were shown and analysed.

Results

PSTs reported that the use of the tool was medium demanding. Several PSTs said that they felt distracted from observing the lesson by pushing buttons on their phone. By comparing pairs of coding graphs, we could identify similarities and differences between the coders, between code sets, and lessons. Comparing the graphs led to clarifications regarding how the individual PST interpreted the codes. During this process, a multitude of different views on the actions within the same lesson emerged showing that different evaluations of that lesson were possible.

Characteristics of coding graphs depending on the used code set

In the following, I present one coding graph from each code set applied to the same lesson. I describe the characteristics of the graphs as well as differences between the PSTs that coded with the same set.

Figure 1 is an example of the Norwegian classroom codes. The teacher codes show no overlap and account for almost the whole lesson time (34 out of 35 minutes). The student codes are also without overlap but cover only about 29 minutes. Coding for teacher talking and students listening is with one exception parallel. The same applies for teacher summing up the lesson and students taking notes. The two other PSTs using the same code set produced similar graphs. However, they coded students listening almost throughout the whole lesson. They also coded student talk during conducting experiments.

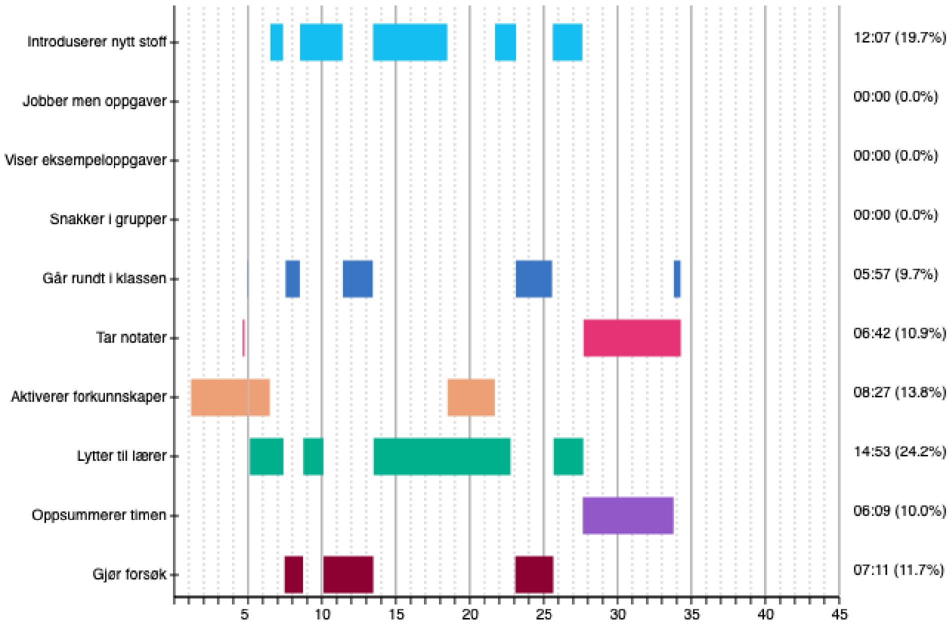

Figure 1. Norwegian class codes. The five teacher codes and the five student codes do not overlap. Certain teacher codes coincide with certain student codes.

Coding graphs based on the DECoSTE codes looked different from those described before (see figure 2). Here, several codes were fragmented, i.e., they consisted of many short instances (seconds). This applied to both teacher and student codes. However, doing experiments, taking notes, and teacher highlighting the phenomenon had longer stretches of coded time. Some of the coders applied codes related to teacher talk without overlap, whereas others often coded several codes at a time. As with the Norwegian class codes, student activities were less frequent than teacher talk.

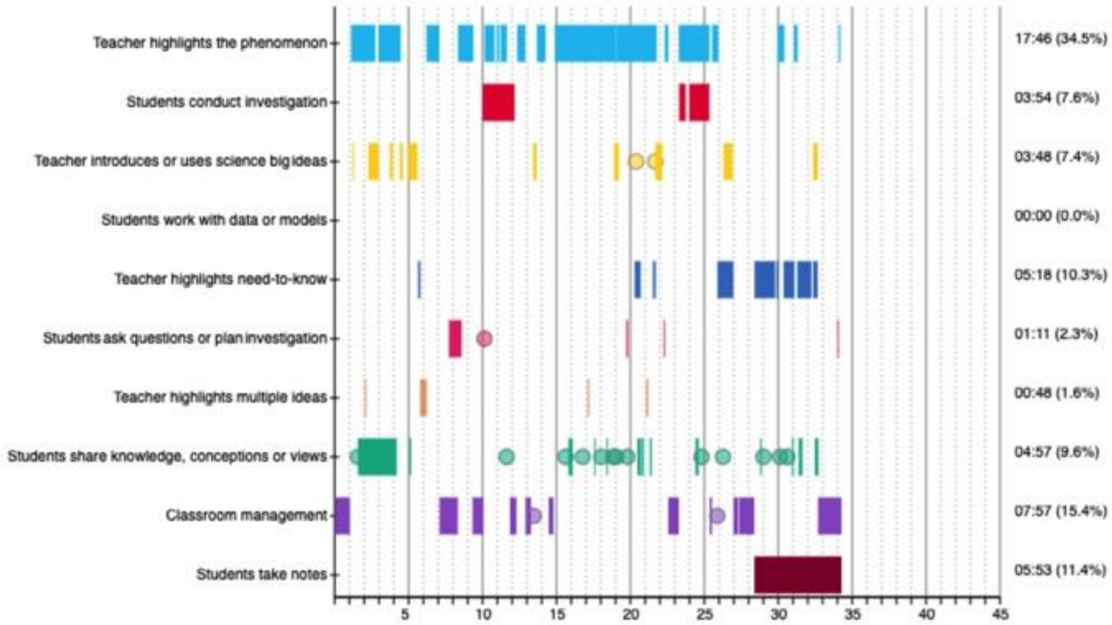

Figure 2. DECoSTE codes. The five teacher codes cover almost the whole lesson (teacher talks). Especially the coherence codes are fragmented (2-4). Students are less active: do experiment and contribute to class talk.

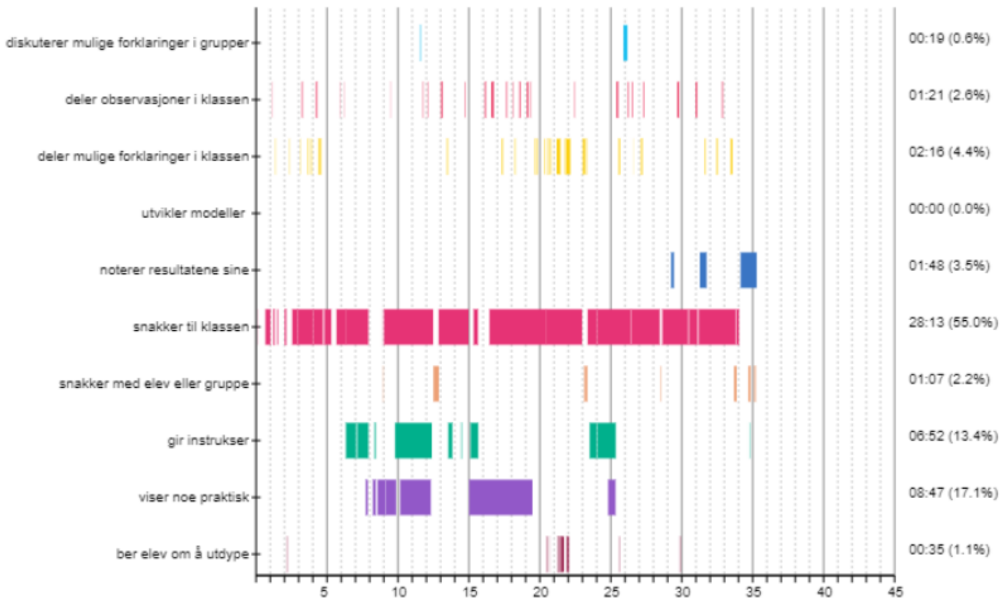

Figure 3. Inquiry codes (student codes on top, teacher codes at bottom). The teacher dominates (whole class talk). He demonstrates experiments. The students contribute with short utterances throughout the lesson.

The graph from the inquiry code set mirrored the teacher dominance in the lesson (figure 3). Student actions were very fragmented (except taking notes), and they were related to the teacher talking to the whole class. In the other two lessons that were coded using this code set, student activities also were fragmented, rare, and connected to classroom talk or group work during experimenting. This indicates that the coded lessons followed a pattern that did not include explicit group work on observations and data and the exchange of observations and suggestions for explanations in the whole class.

Intercoder agreement

Comparing the coding within the different groups of PSTs, there was a tendency towards more agreement regarding the inquiry codes and Norwegian class codes. This included both amount of time coded for an activity and location of the different activities. However, all code sets contain codes that can be interpreted differently and hence lead to variation. This is expected because the PSTs had not been introduced to the different codes or trained before they did the coding. A brief description of when to apply a code would probably raise agreement between coders. Many disagreements were due to codes where PSTs could distinguish between explicit activities like having a group discussion about a question and "naturally occurring activities" like students chatting during an activity. It is easier to code explicit activities especially when they are announced by the teacher, and the information might also be more useful for discussion or reflection.

There was also a tendency that low-inference codes showed better agreement than high-inference codes. This is probably because coding was conducted live, i.e., PSTs watched the video and coded without being able to go back and change codes. Being able to watch situations several times is vital to achieving good agreement with high-inference codes. Therefore, the use of codes that need less inference and are easier to observe directly might reduce variation in coding when using the DOT.

Using the DOT to reflect on PSTs' own lessons

When introduced to the DOT, I realized its potential to trigger reflective discussions on PSTs' own lessons. In the case of this chemistry education course, a design including recording a lesson on video is not realistic because of data protection rights. It was also not feasible to let fellow students code a lesson because students are working in pairs only in one of their two subjects. Therefore, obligatory visits of teaching staff from UiB at the schools were regarded as suitable. However, because of the established practice of taking detailed notes including class dialogues and concerns that using the DOT could interfere with this practice delayed the trial.

Based on the experiences when the PSTs coded lesson videos, a set of only six codes was developed (see table 3). The set consists of three pairs of codes where the two codes from each pair are mutually exclusive. They are broad and often related to visible changes in the classroom (i.e., students stand up to get items for an experiment) or announced by the teacher ("Talk to your neighbour."). The two teacher categories distinguish between a whole class and an individual-student or student-group orientation. When both codes are deactivated, it indicates that the PST is doing something not directly related to the current student activity (i.e., writing on the board, while students work with an assignment). Two student codes concern communication (taking to each other about an issue or talking to the teacher) and two the social aspect of activities (working individually, i.e., often with tasks, or working in groups, i.e., mainly doing experiments). The current practice reported here has been not to code for student communication when they were working with tasks or experiments. Such talk is common but has a different role in the teaching and might blur the visibility of students' content-related contributions in class.

The teacher …	addresses whole class	talks to individual students or groups (includes also monitoring students)
The students …	talk to whole class (answer teacher question, report from group discussion, or ask a question)	talk to each other (only used when teacher asks students to talk to each other, related to problem or question)
The students …	work individually (often work with tasks from textbook)	work in groups (do an experiment)

Table 3. Observation codes for PSTs' own lessons.

Sample

The DOT was used when visiting 18 PSTs in eleven different schools teaching chemistry in grade 12 and 13. PSTs either conducted an individual lesson or they taught together with a fellow PST distributing certain activities between them. In many cases, two consecutive lessons in the same class were observed. The time graphs were shown during the reflective discussion after the PST had given a brief account of the lesson experience and a general evaluation.

Experiences Using the DOT

It was relatively easy to use the DOT during lesson observation, and it did not interfere with taking notes. The transitions from one activity code to another are usually clearly marked. The only challenges were the codes for teacher orientation and student talk in whole class because these were not always clear (i.e., teacher question during presentation of new content). These issues are, however, of no significance because they do not affect the general patterns.

In the following, I show three time graphs of quite different lessons. They highlight what coding with the DOT can capture and what not and how that relates to coherent science teaching.

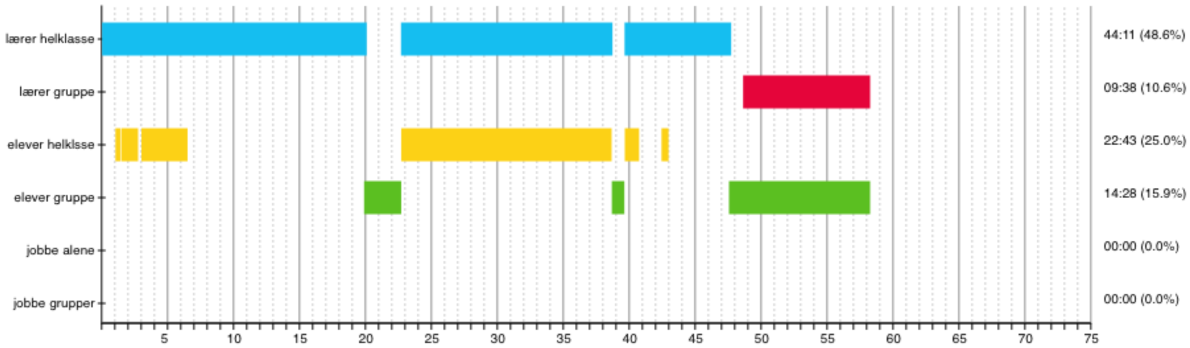

Figure 4. Time graph of a lesson on thermodynamics.

The lesson represented in figure 4 was on thermodynamics. The PST started with a repetition of the term entropy until about minute 20. The PST asked students for a definition and its application. Students volunteered to answer. When the PST introduced a new term (spontaneous reaction), he asked the students to talk in pairs about what that could mean. After two minutes, one student answered ("It happens on its own."). After that, the PST showed several pictures (i.e., a waterfall, rusting iron, and more) and asked students to decide on whether spontaneous or not. In some cases, students did not agree on their evaluation. In these cases, the PST pointed to the correct answer.

The next term (Gibbs free energy) was introduced by a question that students should discuss in pairs: Can both exothermic and endothermic reactions be spontaneous? Student answers expressed uncertainty, and the PST introduced the equation for free energy and discussed the case of a "cold pack" with the students. Then, students were shown a table with entropy and enthalpy changes being either positive or negative and got time to discuss the resulting free energy in groups. Here, the PST went around in the class and communicated with some groups before the lesson was closed.

The PST's comment when seeing the graph was: "Oh, I talked a lot!" He obviously related the blue stripe to his talking to the class. The graph shows that the PST did not talk the whole time but involved several students in the repetition as well as in the development of new content. Two times, the PST used student talk in pairs to prepare students for new content. Towards the end of the lesson, the student activity could also have been coded as group work, but the main point is that the PST took contact with some of the groups to find out what they were doing.

In terms of coherence, the graph itself does not show any of the four perspectives. Only by adding the communication between PST and students, it becomes clear that the lesson was focused on terms and concepts, not a phenomenon, that it included small portions of inquiry by applying concepts to real world situations, and that the students had to think hard to figure out answers. Concluding the reflective discussion, we agreed that the lesson could have benefited from fewer and simpler examples, a deeper discussion of the involved concepts, and clearer conclusions. At the same time, we all admitted that the topic was too complex to cover it in a couple of lessons in a satisfying way.

Figure 5 shows the time graph of a lesson on acids and bases. This lesson was more structured than the previous one and had a recurring pattern that divided the lesson into blocks of 7 to 15 minutes. In each block, the PST gave an assignment to the students, which they were supposed to work upon individually or in a group. During the student work, the PST went to all students asking for what they did and answering questions. After each phase, the PST invited students to present their answers in whole class. The PST did not monitor the students when they watched a short video where hydrochloric acid and sodium hydroxide solution were added successively to a solution of an indicator in water (minutes 33-35). Here, the PST just asked the students to note down observations, which were shared in whole class before students drew what they thought was happening in the experiment shown.

In terms of coherence, the time graph shows together with the communication that inquiry is addressed through the video, which introduces a problem to the students based on a phenomenon. The students get time to think alone and in groups and their thoughts and ideas are shared in the whole class before taking the next step. In general, the PST elicited students' thinking in a systematic way and made it public in the class.

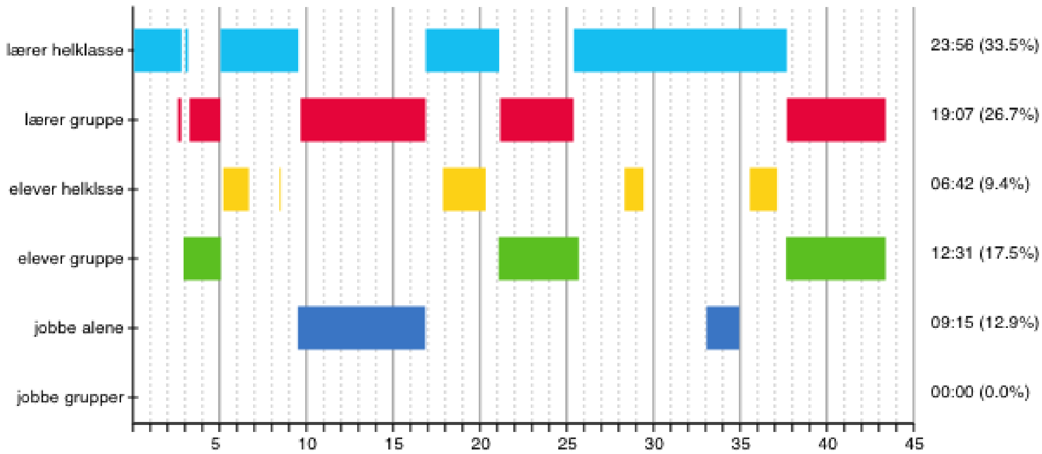

Figure 5. Time graph of a lesson on acids and bases showing a consistent pattern of activating students.

Figure 6 is the time graph from a titration experiment (strong acid and base). It was the second of two lessons. In the previous lesson, students got an introduction to the equipment and started the experiment. Many groups needed more time to finish the titration in the following lesson before the class had a summary of the results.

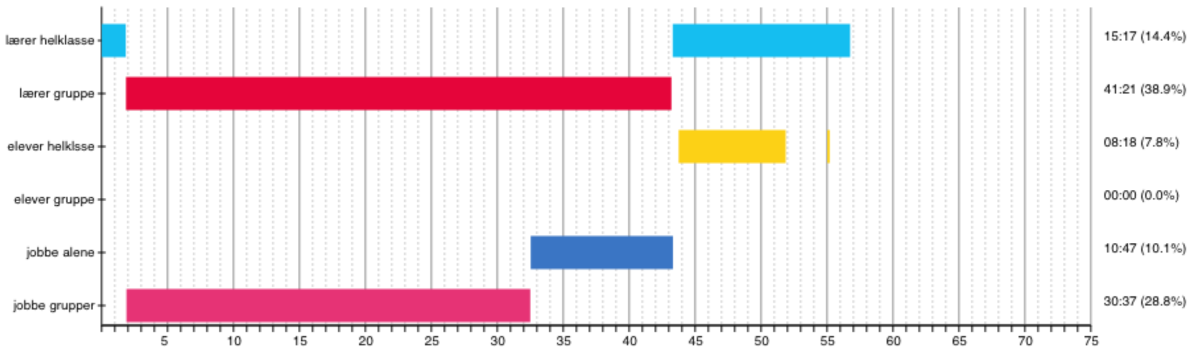

Figure 6. Time graph of the second of two lessons where students conducted an acid-base titration.

The graph shows that students worked for almost one hour with the experiment (including 40 minutes from the previous lesson). Groups that finished earlier began to write their report. During the experiment, the PST had contact with the students and was mainly concerned with explaining the handling of equipment and how to conduct the titration. In the last 15 minutes, the PST went through the calculation procedure for the titration. Here, students were volunteering to propose steps to solve the problem. During the calculations, two different group results were mentioned, but there was no comparison of all the results to address accuracy and errors.

The graph indicates that experiments lead to longer periods of time where students work without a systematic monitoring (weak structuring). Especially when the procedure is complex, the practical part absorbs the attention of both the teacher and the students. A similar situation has been observed for working with tasks from the textbook where the teacher is checking what the students can do, but students' difficulties are seldom addressed in whole class.

From a coherence perspective, inquiry and a phenomenon are addressed. However, the titration is used to find out an empirical fact (concentration of a solution) but not to explain or understand the phenomenon. Hence, student thinking is supported to a lower degree.

Implications for using the DOT in science teacher education

The DOT has proven to be a versatile and easy to use tool for systematic observation of instructional activities. When it is used with lesson videos, it is easiest to have six to ten different low-inference codes. A brief description of when to apply the codes and when not may help the students to use the codes consistently. Common patterns and differences between individual coders or code sets can be used to discuss the structure of the instruction or certain approaches like traditional or inquiry teaching. For a deeper analysis of certain teaching situations, it is required to watch those again and pay more attention to the communication to find out how the sequence contributes to a coherent teaching process.

When the DOT is used to code activities in PSTs' own lessons, a set of codes that focus on important activities is required. The codes chosen in this adaptation do not show coherence in the teaching without additional information. The resulting graph can shed light on the lesson's structure and student activation. To be able to identify coherent and less coherent parts in the teaching, the coder or another person should record parts of the communication and other interesting events. The coding graph is then a starting point for discussion and reflection that is complemented by other information from the lesson.