

Exploring a framework to empower Dutch teachers for designing context-based chemistry education

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Introduction and aim of the study

Teachers' active involvement in development and implementation of new curricula is considered as an important factor for a successful innovation. An increasingly popular strategy for teacher involvement is to have teachers participating in the designing of new teaching/learning materials (Parke & Coble, 1997). However, for many teachers, designing new materials is a complex and difficult process (Clandinin & Connelly, 1992). Therefore, curriculum innovations should be accompanied by teacher professional development that not only focuses on how to teach innovative materials but also focuses on how to design them.

The present study focuses on the design, enactment, and evaluation of a programme for such a professional development in the Netherlands. This study is the follow-up of the first cycle of a research project that is reported elsewhere (Stolk, Bulte, De Jong & Pilot, 2005). This project is linked with the planning of a context-based chemistry curriculum innovation for upper secondary schools in The Netherlands. The aim of the study is to gain a better understanding of the relationship between the design and enactment of an in-service programme and the process of teachers' professional development during the programme.

Background and research question

In our project, teachers' professional development is considered from a sociocultural perspective on learning. In line with Galperin (1992), learning is seen as the internalisation of actions in a social setting. A central idea is the concept of orienting basis for an action. It refers to the whole set of orienting elements by which the learner is guided along the execution of an action. According to Galperin (1992), an orienting basis for an action is created by using an orienting chart which is an external presented scheme. For more complex tasks, this chart cannot and should not be made complete (cf. Terlouw, 1993). In that case, learners, especially adult learners, should use a provisional and partial orienting chart that creates a preliminary orienting basis. Subsequently the learner applies this basis while performing the action. During the evaluation, the orienting basis is expanded by reflection on the performance of the action.

Our framework for professional development is an adapted version of a framework described by Terlouw (1993). He based his model on Galperin's theory and distinguished the following learning phases: creation of conditions for professional development, orientation on an action, performance of an action, and evaluation of the performance of an action. He elaborated each phase by formulating specific instructional functions. We adapted the descriptions of the instructional functions by using the evaluation results of the previous project cycle (Stolk, et al., 2005). Our framework consists of two strands: (T) teaching a context-based unit as a representative example of a new curriculum, and (D) designing a new context-based unit. Both strands are connected through the notion that teaching the first unit, that is, using the partial orienting chart, provides teachers with a preliminary orienting basis for designing the second unit. In other words, the teaching strand is nested within the designing strand.

In the first strand, teachers have expanded an *orienting basis for context-based teaching* when they have acquired: (i) an overview of an exemplar context-based unit, (ii) experience with teaching the exemplar unit, and (iii) knowledge of guidelines for context-based teaching. In the second strand, teachers have expanded an *orienting basis for context-based designing* when they

have acquired: (i) an overview of a general model of a context-based unit for deriving design criteria, (ii) experience with designing a sketch of a new context-based unit, and (iii) knowledge of guidelines for context-based designing.

We elaborated the two-strand framework through the instructional functions into a professional development programme for chemistry teachers. Our research was guided by the following question: To what extent does the elaboration of the two-strand framework for professional development empower teachers for context-based designing? The empowerment of teachers was operationalized in terms of their expanded orienting bases for teaching and designing.

Research method

Eight experienced Dutch chemistry teachers were involved in the study. The programme covered five three-hour institutional meetings, led by an experienced teacher educator. The meetings were related to teaching of an exemplar unit in the own schools to students of grade 10 (aged 15-16) at pre-university school level.

The exemplar unit dealt with the issue of property-structure relations at super absorbent materials. The unit was structured by using the following general three-part model of a context-based unit (De Vos, Bulte & Pilot, 2002): (i) introducing a context that would evoke a 'need-to-know' among students (in this unit: a student experiment about the water-absorbing capacity of disposable diapers), (ii) the studying of relevant chemistry concepts (in this study: polymer chemistry) to satisfy the students' curiosity, and (iii) the application of knowledge in a follow-up context (in this unit: a student inquiry project about the water-absorbing capacity of gels and fabrics).

Data were collected at specific moments of the programme. Before the start of the first meeting, each teacher videotaped one of his/her lessons including the use of contexts, and filled in a worksheet about that lesson. All meetings were audio/video-taped by one of the researchers who also made field-notes of the meetings. Worksheets and questionnaires filled in during the meetings were also collected. The lessons with the exemplar unit were video-taped. Post-programme interviews were also held. Two researchers analyzed the data independently. They compared the results, and, when necessary, discussed them in order for reach consensus.

Findings

In the beginning of the programme, the teachers did not have knowledge of the general three-part model of a context-based unit, and the elaboration to the exemplar unit, although they had experiences with previous lessons including the use of contexts. Giving them an active role in the meetings and classrooms motivated them very well during their participation in the program. Regarding the T-strand, the main results can be summarized as follows. The creation of a preliminary orienting base for context-based teaching was accomplished. All teachers succeeded in applying their preliminary orienting basis when teaching the unit in their classrooms. For expanding the orienting basis, the teachers reflected on their experiences. All teachers were enthusiastic about the 'diaper' experiment as a part of the introductory context. They indicated the use of (reformulated) student questions for connecting the first and second part of the unit and the use of (reformulated) student hypotheses for connecting the second and third part of the unit as important guidelines for context-based teaching. Nevertheless, most teachers reported that most of their students encountered difficulties in constructing property-structure hypotheses. The teachers also elaborated some specific guidelines for context-based teaching in terms of 'do' and 'don't' teacher actions in the classroom. Most teachers considered these guidelines useful for their own lessons, although for some other teachers, the guidelines were too general to be very useful.

Regarding the D-strand, the main results can be summarized as follows. For creating a preliminary orienting basis for designing, the teachers used their teaching experiences. All

teachers indicated the issue of taking into account student difficulties in formulating appropriate questions and hypotheses as an important guideline for context-based designing. They all applied this basis when designing a sketch of a new context-based unit. For expanding the orienting basis, the teachers reflected on their design experiences. Regarding the choice of an introductory context, all teachers indicated that the demand of evoking a 'need-to-know' among students is an important principle for context-based designing. Regarding the choice of a follow-up context, they indicated that the demand of a good connection between students' expanded knowledge and this context is also an important principle. According to them, the demand of a good connection between contexts and chemistry concepts by taking care of an appropriate order of introduction of concepts is another important design principle. Nevertheless, some teachers indicated to have become aware of difficulties in designing context-based units, especially regarding connecting contexts with concepts. Regarding designing for own lessons, most teachers complained about lack of time and availability of resources, for instance, suitable student experiments. Nevertheless, all teachers indicated that they are willing to implement parts of the context-based approach in own lessons.

Discussion and conclusion

The findings showed that all teachers acquired experience with designing the three core parts of a general context-based model. Nevertheless, most of them complained about a lack of time and available resources hindering them to design units for their own lessons. For a successful curriculum innovation, this result shows that professional development programmes should also incorporate the issue of finding quick and easy ways to suitable resources for designing context-based units.

To what extent can we generalize our results? Before a programme as ours could become effective, several external conditions need to be met. For instance, it requires a certain amount of dissatisfaction among teachers with the current curriculum, and, moreover, they should feel a need to know more about context-based science education. However, our results also have limitations in generalization. For instance, all our teachers were active participants in the professional development circuit, but this does not mean that every other teacher will be attracted by the programme.

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