Context-based science curricula: Exploring the didactical frictions between context and science content

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Introduction

In context-based science curricula – such as *ChemCom*, *PLON*, *Salter's Science*, *Chemie im Kontext* and *Physik im Kontext* – practical applications and/or socioscientific issues act as a starter for the teaching-learning of science. It was and still is expected that relating science to 'everyday life' would make science teaching more interesting for a larger proportion of the students, that they would be more motivated to learn about and thus would reach a better understanding of the subject knowledge involved. This implies that the science content presented is necessary, and thus its learning is meaningful, for solving a practical or theoretical problem set by the context. In our experience, however, this relation between context and science content is not quite as unproblematic as it seems.

From the point of view of designing teaching-learning materials the problem appears to be a twofold didactical friction between context and science content: is science content really necessary for solving the practical or theoretical problem set by the context, and, if so, which science content?

This paper attempts to explore these didactical frictions by means of a representative example from the PLON curricula – the physics unit *Traffic and Safety* – and to tentatively answer the question whether the idea of restraining contexts to authentic practices – as done in the chemistry unit *Water Quality* – could be helpful in solving these. The theoretical framework underlying this exploration is the *problem-posing approach* to teaching specific science topics.

A problem-posing approach

In general, 'traditional' science curricula as well as most context-based curricula adopt a teaching-learning strategy of top-down transmission, without really taking into account what students already know, think and are interested in (Lijnse, 1995). Such teaching almost unavoidably results in a process of forced concept development, which may – at least partly – explain the often disappointing cognitive learning results in science education. This points at the necessity of an improved teaching-learning strategy that takes the students' existing pre-knowledge and skills into account, and that provides them with a motive to extend these in a specific direction. This reflects the adoption of the perspective of educational constructivism (Ogborn, 1997), combined with the idea of a problem-posing approach with a core of developing content-related motives that drive the students' learning process: a coherent sequence of teaching-learning activities designed on the basis of a profound knowledge of the students' relevant pre-knowledge as being coherent and sensible (instead of being wrong) and using their knowledge productively (instead of immediately trying to change or replace it) in a social process of the teacher's and students' coming to understand each other (Klaassen, 1995; Klaassen & Lijnse, 1996).

For the purpose of designing teaching-learning sequences these ideas have been elaborated in terms of a 'didactical structure' in terms of four subsequent phases with specific didactical functions that have to be fulfilled in such a way that they assure the necessary coherence in the activities of the students (Lijnse & Klaassen, 2004):

- Phase 1 – Orienting and evoking a global interest in and motive for the study of the topic.
- Phase 2 – Narrowing down this global motive to a content-specific need for more

knowledge.

- Phase 3 – Extending existing knowledge in view of the global motive and the more specifically formulated knowledge need.
- Phase 4 – Applying this knowledge in situations the knowledge was extended for.

In the following two sections these ideas will be used to analyse the two units mentioned above on their 'didactical quality' – as far as limited space permits.

Learning in contexts

For taking a closer look at the didactical quality of the PLON units in terms of the theoretical framework outlined above it suffices to take the unit *Traffic and Safety* as an example – as all units show roughly the same format (Eijkelhof & Kortland, 1988).

The aim of this unit is to have students learn about the relationship between force and motion in the context of traffic-safety measures such as safety belts, crash helmets and speed limits. The related 'contextual' aim is to make students aware of, and thus promote, responsible traffic behaviour through their understanding of the physics involved.

Although – in reconstruction – the unit follows the phase structure outlined in the previous section, there are two serious didactical frictions in the elaboration of these phases. The first didactical friction occurs in the transition from the first to the second phase. In the first phase the students are asked to infer the effectiveness of safety measures from a diagram showing the number of traffic casualties over the years. So, during the second phase a student might wonder why any physics knowledge is needed at all – as the effectiveness of those safety measures has already become quite clear. The unit therefore does not offer students a content-related motive for an extension of their knowledge about force and motion. The second didactical friction relates to the transition from the second to the third phase. If any physics knowledge would be needed for understanding the effectiveness of safety measures, it would be about the forces the human body can endure and the magnitude of forces acting on the human body during a collision without and with a safety measure taken, including ways to measure and/or calculate these forces. As a consequence, about three-quarters of the rather traditional physics contents of the unit can be considered superfluous. In essence, the unit *Traffic and Safety* is (and as a hypothesis: just like all other PLON units) a systematic treatment of a certain class of physics phenomena, driven by a theoretical orientation – comparable to the more traditional physics curricula.

Research has shown that students appreciated the unit, although it is unclear whether this was caused by the context-based approach or by the activity-based learning. They did, however, not reach a better understanding of the physics contents involved (Kortland, 2005).

Learning in the context of authentic practices

A possible solution for solving the identified didactical frictions is giving a more strict meaning to the word 'context'. Instead of seeing 'context' as everything in everyday life to which science knowledge can be connected in one way or another, it would refer to a communal practice of professionals bound together by a common purpose of solving a specific science/technology-related problem and by a characteristic procedure leading to a solution of such a problem with the necessary scientific/technological knowledge, skills and attitudes serving as an input into such a procedure. In an instructional version of such an authentic practice its common purpose could provide students with a global motive. Their intuitive awareness of a characteristic procedure in such a practice could provide them with a sense of direction of their prospective learning process. And mimicking such a procedure could provide them with content-related motives for extending their knowledge, skills and attitudes as a necessary input into this procedure.

As an example we will take the chemistry unit *Water Quality*, inspired by the authentic practice in which analysts evaluate the quality of water with a certain function (such as drinking it or swimming in it) according to standard test procedures (Westbroek, 2005). Characteristic for this practice is that there is an issue (water quality), that there is a procedure (standard protocol for testing) and that there is a problem to be solved (judgement of water quality based upon the findings of the standard protocol for testing). The instructional version of this authentic practice, of course, differs from its real life setting. In the authentic practice competent professionals perform the job, knowing why they do what – what standard parameters to test for water with a certain function, which standard tests to perform, how to interpret the results of these tests taking into account their reliability against the standard criteria to be met. This, of course, does not hold for students. In the instructional version of the authentic practice they will have to learn, whilst knowing why, these science contents in order to be able to solve the problem they now wish to solve.

Research on this unit shows that the approach certainly helped in designing a coherent teaching-learning sequence, but also, and even more important, that students recognised and appreciated the logic of the flow of teaching-learning activities and understood its science contents well enough (Bulte *et al*, 2006).

Conclusion

The idea of using authentic practices as contexts seems promising – at least at the level of separate units. However, whether such an approach is feasible at the level of a complete and coherent science curriculum and whether this would lead to a curriculum with an acceptable science content are still open questions, currently under investigation. The guess is that it will be necessary to consider different types of authentic practices, not only vocational ones (such as in the unit about water quality) but also everyday life practices and scientific practices tuned to the age of the students and the ability stream they are in.

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