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Interactive comment on "Addressing secondary students' naïve ideas about freshwater springs in order to develop an instructional tool to promote conceptual reconstruction" *by* S. Reinfried et al.

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We thank Prof. Nonner for his detailed review and his suggestions. From the reviews we received recently we conclude that the term "naïve ideas" is difficult to understand if one is not familiar with educational research. The term "naïve idea" is a standard term in conceptual-change-research and is not in any way meant in a judgemental way (see .p. 1593, line 19-22). It simply stands for learners' everyday ideas, personal ideas or pre-instructional ideas. We consider changing it in the final manuscript for a more neutral term that is less ambiguous.

Prof. Nonner referred in his review to Table 1, which relates to a questionnaire con-

sisting of closed questions. It is true that the percentages in Table 1 suggest that the students disposed of some understanding of hydrological processes. In our research we included more data sources in the form of drawings and sketches produced by the learners and an open question which asked the students to produce sentences or short texts. These data sources (Table 2) indicate that the answers given by the students in the questionnaire are mostly not linked to an understanding of subsurface process. Even if the students answered a question in the questionnaire in an affirmative way this answer was not connected to knowledge that was transferable into a more or less appropriate drawing. This discrepancy has to do with students' mental representations of springs that were based on their everyday ideas. Therefore it is important to take into account that our approach is based on more criteria than referred to in the review.

It is of course correct to say that not all children have the same misconceptions and that some children dispose of prior knowledge which is close to science-based knowledge. Nevertheless, from this and previous studies (e.g. by Dickerson & Dawkins, 2004; Dickerson, Callahan, Van Sickle, & Hay, 2005; Reinfried, 2006) we know that the "misconception" of groundwater being stored in subsurface caves and canals/veins is omnipresent in laypeople. Similarly, the fact that water can percolate through "hard and firm" rocks is incomprehensible to most people. This is why we focused on springs flowing out of clastic sedimentary rocks (hillslope springs). Nevertheless, we will improve the title of our paper in such a way as to mention that our paper focuses on hillslope springs.

Prof. Nonner is concerned that we underestimate the intelligence of children in grade 7. According to the findings of the psychology of learning, a particular content structure for instruction has to be developed based on the student's point of view, by taking into consideration their pre-instructional conceptions and their paths of learning to attain the goals of science teaching. The students' conceptions and frames of interpretation must by all means be taken into account if deep learning and understanding is to be attained. The science content structure cannot simply be transferred, even if in a somewhat simplified manner, into science instruction in secondary schools. A content structure of science instruction in schools has to be constructed on the grounds of an analysis of the educational significance of the content and on the basis of students' learning difficulties. This is why we used the analogy of the sand pit which is linked to experience-based cognitive schemata understood by everybody and suitable to serve as the basis for the construction of more complex concepts.

Based on this approach we pursued the following goal: We did not strive for hydrological completeness, but picked just one example from all the various spring types that is best suited to inducing a conceptional change of the idea that groundwater flows in subsurface caves and veins. We think that the example of the hillslope spring meets this target best. Our idea was to show that the "misconception" that rocks are generally not permeable is wrong and that caves and veins do not constitute a precondition for the formation of springs. We therefore preferred to restrict the scope of spring types to just one example in favour of a purposeful confrontation of the learners with the main learning difficulty and in favour of a better understanding of the concept of springs in general (see p. 1603, line 24-29 and p. 1604, line 1-2).

We comprehend the criticism that concerns our use of the spring line as the sphere of discharge of hillslope springs. We were aware of the fact that the occurrence of a spring line in nature is a special case. When designing the worksheet, our intention was to simplify the complex concept of springs to make it easily learnable and comprehensible. Therefore we decided to use the spring line as an anchor to state a problem that should be solved in the course of the learning process. The phenomenon of the spring line is suitable to demonstrating the interrelation between the occurrence of springs at a hillslope and the changes of the properties of layers of clastic sedimentary rock in the hill.

In a previous study we have shown that Prof. Nonner's suggestion "to take a textbook on hydrogeology as an example and adjust/simplify relevant pictures in them to present them to children" would not bring about the desired effect. In a study with lower sec-

ondary students about their comprehension of the greenhouse effect we contrasted learning material developed according the criteria of the psychology of learning with learning material taken from a textbook adjusted to learners on the secondary level. The knowledge gain of the first group not only exceeded the one of the second group but was also more persistent over time (Reinfried, Aeschbacher & Rottermann, 2012).

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