Review for the following paper in HESS:

Title: Addressing secondary students' naïve ideas about freshwater springs in order to develop an instructional tool to promote conceptual reconstruction
Author(s): S. Reinfried et al.
MS No.: hess-2011-389
MS Type: Research Article
Special Issue: Hydrology education in a changing world

Overall quality of the discussion paper ("general comments")

The approach adopted in the paper appears to be sound. Questionnaires and interviews are used to find out about the "concepts of springs" with 13 year old children in Switzerland and teaching methods are offered adopting an illustrative/textual worksheet following a problem based approach. In addition, the use of the English language is excellent and very well readible.

Nevertheless, I have problems with the way in which the conclusions of the questionnaires and interviews are formulated and the contents of the worksheet. The conclusions and worksheet tend to under-estimate the intelligence of children which have apparently completed their primary education (see my specific comments).

Individual scientific questions/issues ("specific comments")

In section 5.1 to 5.4 and 6, the misconcepts on springs are well-explained and also summarised at the end of section 6, but the conclusions focus too much on the minority of the children with these misconcenpts and too little on the children having an intelligent opinion on springs. Looking at Table 1, for example the majority makes the correct connection with groundwater (underground processes),the hydrological cycle (they very cleverly see the relation between rain and spring flow) and water quality (children see springs as natural sources of water unaffected by pollution, which is not such a bad notion to start with). The table also seems to indicate that the children have not had any formal education in hydrology (e.g. as part of geography, for example) since, at the questions requiring hydrological knowledge (e.g the ones with aquifer and blocking layers in them),they very wisely select the neutral option. In designing worksheets for lecturing it makes quite a bit of difference if this material is developed with the notion that (all)children have misconcepts on springs than with the idea that most children have intelligent ideas on springs, but that the misconcepts that (some) children have, should be explained.

Then the worksheet. ***Picture and text 1*** *may give the impression to children that springs generally occur at the same height (despite the addition of the incorrect word 'sometimes'). This is not true. Both in unconsolidated and consolidated rock springs can occur at different elevations.* ***Pictures and text 2 to 5.*** *Here the correlation with a sand pit is drawn. I am not sure whether this is the optimal approach since a) the idea that both unconsolidated rock with intergranular porespace and consolidated rock with space at fractures, etc can both lead to spring formation is not explained*

(the focus is only on unconsolidated rock)and b)the concept of the water table separating the unsaturated zone and saturated zone and the role the 'table' plays in spring formation is also not indicated in the pictures. Using the water table concept is better than to refer to some high hydrostatic pressure at the bottom of the pit which does not grasp the notion of children. ***Picture and text 6*** *try to bring in the emergence of springs in consolidated rock (sandstone), but the picture does not show any fracturing in the rock which is in many places the major reason of spring formation (instead the water still flows in between the grains to the springs which certainly does not occur where the grains are cemented).*

In designing material for children I would take into account that most children have already intelligent ideas and rather take a textbook on hydrogeology as an example and adjust/simplify relevant pictures in them to present them to children also taking into account my comments above. The problem based approach (let the children first guess 'what may happen underground sothat springs are formed) that you advise is fine.

Technical corrections "technical corrections": typing errors, etc.)

Language is fine, no comments

Scientific Significance:
Does the manuscript represent a substantial contribution to scientific progress within the scope of Hydrology and Earth System Sciences (substantial new concepts, ideas, methods, or data)?

I am not sure whether the development of educational material can be classified as contribution to scientific progress. Howver, with corrections, the paper can be considered as a contribution to the development of educational material,

Scientific Quality:
Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?

The approach and methodology adopted are fine, but results are not discussed in a balanced way (see comments above)

Presentation Quality:
Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)?

All presented in a nice way although I have my problems with the pictures in the worksheet (see above)

J.C. Nonner; 5 March 2012