Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-206-AC2, 2020

Hydrology and Earth System Sciences
Discussions
Open Access
EGU

Interactive comment on "Teaching hydrogeology in the field: the bottleneck in student conceptual model development" *by* Joaquin Jimenez-Martinez

Joaquin Jimenez-Martinez

joaquin.jimenez@eawag.ch

Received and published: 3 October 2020

R: In summary, the paper presents critical issues in the teaching of groundwater hydrology and all related aspects. The overall impression of the paper is excellent. The authors have complied to the guidelines of the HESS journal.

A: I really appreciate the positive feedback from the reviewer.

R: The language and the use of subject technical terms and typical to the discipline of groundwater education such terms include Inquiry-based learning, prior knowledge and classroom teaching although such language is not common among general hydrogeologists whose focus is usually in field and lab work not classroom work.

A: An effort was done in order to use and adapt the language typically used by the

Printer-friendly version

Discussion paper

pedagogic community to the particular field in hydrogeology. Therefore, the current study can be relevant for other disciplines with similar teaching approaches.

R: The aim of the study presented in the paper is clear and the two research questions being asked on page 7 lines 192-196, section 3.3 are very good and measurable.

A: I thank the reviewer for highlighting this point.

R: The research has scientific merit and the method followed produced reliable and valid results although the sample size calculation was not clarified but the sample population that produced results was described and the justification for the study population was implicitly provided when one looks at table 1 lines 139-143 on page 5.

A: I thank the reviewer for his positive words. The sample size was provided in the text, while the sample population was provided in Table 1.

R: The argument presented in the paper is logic and the motivation for the argument was provided. However, the psychological approach on mental models was not accompanied by factors for such differences among the sample subjects although a reader could deduce such factors based on information presented on table 1 lines 139-143 on page 5. Factor for such prior knowledge could have been elaborated more. For example, does prior knowledge means lessons on groundwater field-school and modelling during undergraduate levels before at masters' level? This is what it seems to imply.

A: Prior knowledge in this study means courses that students have attended (either at BSc or at MSc level) and that are related with the Groundwater Field Course. It is expected that the previous knowledge controls the degree of elaboration and appropriateness of the mental model of each individual, however, this is not always necessarily the case. Mental models are modulated by other capacities such as conceptualization or spatial visualization.

R: Interpretation of results is clear and followed scientific statistical methods. However, how factors such as size of the class, language used, subjects taken before or

alongside groundwater hydrology, level at which students learning groundwater, exposure to field and lab equipment and field-school at undergraduate level would have produced probably slightly different results when groundwater hydrology is introduced at Masters level. In some countries like South Africa especially at the University of the Western Cape, groundwater hydrology are from undergraduate students [Years 1-4] to postgraduate students [Masters and PhD students]. In addition, the use of English as media of teaching had been assumed to be clear to all students which are not the case. The education background in terms of exposure to natural science subjects has been assumed to be uniform which is not true. All these factors make me agree with the authors of the paper that specific lessons in the classroom, prior to going to the field to introduce methodologies for conceptual model expressions should be integrated into courses based on active learning. In addition, I agree that inclusion of physical models for classroom teaching, prior to going to the field will help students understanding of conceptual models [Lines 296-301 page 11

A: I agree with the reviewer that the listed factors such as size of the class and language can play a role in the final result of this study. I agree also that probably the best strategy Is to introduce concepts of groundwater hydrology all over undergraduate and graduate years. Because the latter can result extremely difficult, the alternative is to introduce methodologies for conceptual model expressions (including physical models) just before to go to the field.

R: Specific points about the paper [with highlights pages and paragraphs] The paper presents valid research that tells us something new about how we should train our young groundwater hydrologists. Other key points in the paper are as follows:

Teaching strategies: Lecture, field and practical classes method of teaching remains the common one among Groundwater hydrology educators.

A: I agree.

R: Heterogeneity in prior knowledge of learners will remain prevalent because ground-

water hydrology is applied science and it draws on learners with diverse background

A: I agree.

R: Provision on appropriate basics in groundwater flow and transport should be promoted and support and in addition I add that recharge-discharge topic should be introduced at undergraduate with physical models and conceptual models during field-schools trips in order to grow students in modelling world

A: I agree. This is currently done in our undergraduate and graduate groundwater courses.

R: Implementing the in-situ-lecture-based explanation [theoretical knowledge] with inquiry-based learning [data gathering, analysis and interpretation] as shown on page 3 lines 88-89] in groundwater hydrology lessons from undergraduate to postgraduate will strengthen the modelling and address the problems being presented in this paper.

A: I agree.

R: Spatial visualization versus visual penetration ability as presented on page 4 lines 119-125. What seems more problematic is the visual penetration ability among many students. Students tend to understand spatial visualisation fasters when they are in the field during field-school trip and tend to draw cross-sections or profiles easier of what they see on the surface but the ability for visual penetration remains a challenge. [It is like asking them to draw a conceptual model of heaven with all angels signing or dancing]. At this point student with geological background tend to understand this type of visualisation better and quicker if they learned geological cross-sections.

A: I agree.

R: The paper was based on the case study that based on master curriculum in groundwater hydrology. However, if undergraduate curriculum in groundwater hydrology was used, maybe results could have been different. At Masters' level, students have acquired prior knowledge from various disciplines as shown on Table 1 and indeed such

prior knowledge can influence their application in groundwater hydrology tasks on conceptual modelling. Nonetheless, it was a good approach because even at that Masters level many students at their undergraduate learned to get better marks at undergraduate level, so their prior knowledge may not translate into skills-based outcome when asked to perform a modelling task in the field.

A: The list of courses (Table 1) includes undergraduate and graduate curriculum (not only graduate).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-206, 2020.

Printer-friendly version

Discussion paper