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Hydrology and Earth System Sciences Discussions

Interactive comment on "Assessing student understanding of physical hydrology" *by* J. A. Marshall et al.

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Journal: HESS Title: Assessing Student Understanding of Physical Hydrology Author(s): J.A. Marshall et al. MS No.: hess-2012-340 MS Type: Research Article Special Issue: Hydrology education in a changing world Author responses to referee comments.

Responses to Referee #1

The authors thank the referee for helpful and insightful comments. The referee has clearly articulated two reasons to investigate student understanding: 'informing teachers of how to teach better' and 'understanding something fundamental about the learning process.' As the referee guessed (and we should certainly make more evident in revisions), this work is a necessary preliminary step toward the former. As stressed in the paper, prior to assessing any way of teaching hydrology, it is first necessary to provide a yardstick against which the outcomes can be measured. In curriculum development, this approach is often referred to as "backward design" (Wiggins & McTighe, 2005), that is, clearly articulating the goals and how they will be assessed before designing the curriculum.

We agree with the referee's suggestion that semi-structured interviews would be useful, and indeed necessary, in gauging student interpretation of the survey items and elucidating the meaning of student responses. We did pilot the survey with a small sample of respondents to check for interpretation of the items, and have been interviewing students about their learning in the class, as part of the larger curriculum study described in the introduction, but these interviews have not focused on the survey items specifically. In response to the referee's comment, we will add a set of debriefing interviews specifically about responses to the post test.

The referee is exactly right in indicating that this work is, and should be, only the beginning of a larger investigation evaluating curriculum reform. As part of a larger study, we have been interviewing students about concepts with which they struggle, and what has (and has not) helped them to make progress toward understanding. As noted in our paper, the curriculum reform we intend to evaluate will be implemented at a later stage, after student interaction with the traditional course has been investigated. We will rewrite the conclusion section to emphasize this ongoing work.

Finally, we also agree that a standardized test is not likely to be of use to the hydrology education community at this time, although there certainly is movement in that direction among geoscience educators (e.g., Libarkin & Anderson, 2005). It is specifically for that reason that we are employing and reporting an alternative to that methodology, one that employs open-ended responses and evaluation with a rubric, as opposed to dichotomous (right/wrong) responses. Indeed, we do anticipate, as the referee notes, that the approach trialed here ‘could lead to concrete benefits in instructional design and educational approaches.’

Libarkin, J. C. and Anderson, S.W., Assessment of learning in entry-level geoscience courses: Results from the Geoscience Concept Inventory. Journal of Geoscience Education, v. 53, n. 4, September, p. 394-401,2005.

Wiggins, G. and McTighe. Understanding by Design. Chapter 1: Backward design. Upper Saddle River, NJ: Pearson, 2005.

Responses to Referee #2

1. The referee correctly identifies the number of participants in this initial study as small. The study reported here focuses exclusively on articulating the goals of physical hydrology education and developing an instrument and rubric to assess whether they were met. As we indicated, this work is part of a larger study that will indeed involve additional sections of this same course (both graduate and undergraduate). We would also welcome the opportunity to work with instructors of similar courses at other institutions. Indeed, reaching out to others in hydrology education is one of the primary reasons for submitting this article. We could disaggregate the undergraduate and graduate populations in the study, but, as the range of student preparation varied within the two conditions (in terms of mathematics, physics and hydrology background) as much as between them, and as the number for each condition is so low, we did not feel this would be a useful exercise until data from additional sections are gathered.

2. The referee is correct that the abstract focuses on the process of developing the rubric (i.e., the process of characterizing student thinking) rather than the results. We will revise the abstract to focus on the findings from the student surveys (i.e., the student thinking that yielded the rubric categories.)

3. The referee has made an excellent point that more information about the purpose of the course and the background of the students would be useful. The course is taught

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in the Department of Geological Sciences. It is cross-listed as an upper division undergraduate and a graduate course. The requirements for the two courses (homework, exams, projects) were essentially the same; the graduate students were occasionally assigned an extra homework problem. The students taking the course are science (physics, geology, biology) or engineering majors, but sometimes geographers take it. The graduate students are typically from the geosciences. Thus, the undergraduate students are required to have a stronger background in terms of coursework, but the graduate students are expected to have more experience. For undergraduate students majoring in Geological Sciences, the prerequisite is Calculus 1 and a lower division (introductory) hydrogeology class; there is no prerequisite for the graduate students. The course is required for: (1) a BS in Geology with Hydrogeology Emphasis and (2) a BS in Geosystems Engineering (a hybrid Petroleum Engineering and Hydrogeology program). The course is an elective for the BS in Environmental Science. We did not ask students to identify their background in hydrogeology on the survey instrument. Surveys were identified with regard to whether the respondents were undergraduates or graduates. We will add this additional background information about the course to our revised submission.

4. Since the focus of this article was on the method of assessment (i.e., the instrument, the rubric and the process of implementing them) we did include details of the curriculum, but we will add a chart to document the topics in the syllabus and the time spent on them in our revision. The details of the two different versions of the curriculum, i.e., the traditional curriculum being implemented at the time of the study and the reformed curriculum based on student learning with a data and modeling driven approach (Merwade & Ruddell, 2012) developed for MOCHA (Wagener et al. 2012) using COMSOL (Singha & Loheide, 2011, Li et al., 2009), are indeed pertinent to the larger curriculum study. The results from the assessment prior to (pre implementation) and after the traditional course (post implementation) are given only as an illustration of how we might assess student understanding (the method) as opposed to a detailed investigation of the effectiveness of the curriculum (which is indeed part of the larger, ongoing study.)

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5. The basic instructional method used here is a traditional lecture/homework/summative project format. We deliberately refrained from implementing the COMSOL based curriculum intervention under development (or innovative teaching techniques) in order to provide a baseline for comparison.

6. The revision of Q1 was implemented in revisions of the rubric made based on the responses obtained as part of the study described here. The revised rubric will be used in future pre/post assessments as part of the larger curriculum study.

7. As the referee indicates, we have not been clear in our use of the terms pre/post and control. A pre/post methodology was used in this study to determine the change in responses for a control (comparison) population as part of a larger, ongoing study. In the larger study, pre/post differences will be compared between two populations: the one reported here, who received a traditional version of the curriculum, and a second one, in a future instantiation of the course, who will receive a COMSOL based curriculum intervention. We will clarify this distinction in our revisions.

Li, Q., Ito, K., Wu, Z., Lowry, C., and Loheide, S.P.: COMSOL Multiphysics: A novel approach to groundwater modeling. Groundwater, 47(4), 480 – 487, 2009.

Merwade, V. and Ruddell, B.L.: Moving university hydrology education forward with community-based geoinformatics, data and modeling resources Hydrol. Earth Syst. Sci., 16, 2393–2404, 2012. www.hydrol-earth-syst-sci.net/16/2393/2012/ doi:10.5194/hess-16-2393-2012

Singha, K. and Loheide, S.P.: Linking physical and numerical modelling in hydrogeology using sand tank experiments and COMSOL Multiphysics, International Journal of Science Education, 33:4, 547-571, 2011.

Wagener, T., Kelleher, C., Weiler, M.,McGlynn, B., Gooseff, M., Marshall, L., Meixner, T., McGuire, K., Gregg, S., Sharma, P., and Zappe, S.: It takes a community to raise a hydrologist: The Modular Curriculum for Hydrologic Advancement (MOCHA). Hydrol.

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