

Interactive comment on “It takes a community to raise a hydrologist: the Modular Curriculum for Hydrologic Advancement (MOCHA)” by T. Wagener et al.

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Both reviewers have very positive opinions about our manuscripts. Below we outline the changes we intend to make to the manuscript regarding the reviewers' comments. This adjustment allows us to clarify some ambiguous points and to tighten the manuscript.

REVIEWER 1

Thank you for your interesting paper on the MOCHA approach. The MOCHA approach seems to be an interesting, practical and needed approach to the advancement of hydrology education and it fits very well in the scope of the special issue. I have reviewed your paper according to the evaluation criteria as mentioned on the website and have a number of comments. RESPONSE: We thank the reviewer for the positive feedback on our manuscript. While we are responding to the detailed comments below, we do make the point that this education paper does not necessarily fit into the typical structure of a research paper. We are trying to write the most informative paper, rather than strictly following the standard structural guidelines.

General comments: On the structure: Looking at the structure of your paper, I would suggest to describe the objectives and scope of your paper earlier on, or just in the running text of the introduction, because the introduction is very long and it is not so clear where it is leading to. In Section 1.4, you promise the reader you will also identify opportunities, and outline a way forward to advance hydrology education. However, describing the limitations of current hydrology education you immediately start discussing the MOCHA approach. You need to either add the missing parts or adjust your scope. Furthermore there is no method. You describe parts of what could be your method in the Results but you should be precise about what you actually did, so it can be assessed by others. What you mention under Section 5, initial assessment of MOCHA can be partly used as Method. You need to be more specific on how many students reacted positively and if you say for example on page 2341 line 12 “74% in agreement” what do you mean exactly. You have to mention what their answering options were in that survey, whether you used a rating scale for example etc. Section 4.2 and 4.4 should in my opinion not be discussed in this paper. Pedagogical guidelines for course design may be an important component of the MOCHA, but do not need to be discussed here. It would be sufficient if you just mention that it is part of it. Same for 4.4, it is not necessary to discuss the pro's and con's of PPT use in this article. You can just refer to other articles for this debate and leave it with that, as it is too far outside the scope of this article. RESPONSE: These are helpful comments to tighten our manuscript. [1] We will shorten the introduction and provide a description of 'where we are headed' early on in the text. [2] Regarding an outline of opportunities and ways

forward – we initially had such a separate section, but it was getting too long. It is now indeed missing and we will add some text back in to discuss these issues. We will also shorten the discussion of the MOCHA modules somewhat to not lengthen the manuscript further. [3] Describing the assessment in a methods section is a good idea. As mentioned above, we were less concerned with sticking to the traditional paper structure for this particular manuscript. However, we will implement the reviewer's suggestion in the revised version to see whether it works. [4] We will add some survey details as an appendix to the current manuscript. However, we were trying not to repeat too much material from the previous paper and will try to keep a good balance. [5] Sections 4.2 and 4.4 are indeed not specific to hydrology, but generic to education and the use of PPTs in general. We will shorten them, but we do believe that these general educational issues are important to discuss given the focus of this manuscript and the special issue in general.

Specific comments:

There's a mix up of the use of the terms interdisciplinary and multidisciplinary. These are two different things, and should not be used interchangeably. RESPONSE: We clarified the use of these terms.

Page 2324 line 1: It needs quantitative hydrological understanding, but many other things as well. RESPONSE: Yes, the point is that quantitative understanding is needed, not that it would be sufficient. We will rephrase the sentence.

Page 2324 line 10: the need to be central in interdisciplinary teams: you cannot make that statement on the basis of the content of that quotation. He says hydrologists should be part of such a multi-disciplinary team, not necessarily central. It will just as much need the involvement of other disciplines. RESPONSE: Yes, this is our own opinion, given the central role of water. We will adjust the sentence and simply state that a hydrologist is an important component of such teams.

Page 2326 line 25: and what knowledge do you mean then? Substantive knowledge

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about the other fields, the positive attitude (attitude is also part of knowledge) to work on multi-disciplinary issues? Elaborate a bit. You have to define what your community is under Section 1.4. RESPONSE: What we mean is the T shape structure of education discussed in another paper in this special issue. In-depth knowledge of hydrology, while having baseline knowledge of the fields the hydrologist interfaces with. This includes understanding the other sciences language.

Page 2329 line 5. This can also say something about the respondents, you need to add information about the reliability of the survey response in order to make such statements, for example which sub-sectors were sampled? RESPONSE: Unfortunately, this information is now provided in the original survey, though we can (and will) discuss the background of the group surveyed for our own survey.

On the confused self-image of hydrology education, as you state on page 2328 line 23: Line 1 and 2: maybe a confused self-image for IWRM but not necessarily for hydrology education. This statement cannot be logically derived from the survey results. The second survey, especially the results described in line 15 – 20, does not convince me of the confused self-image of hydrology education. It needs additional clarification. RESPONSE: It is clear, certainly from our own survey (Wagener et al., 2007), that there is little consistency in what is taught in a hydrology course today. It might be very clear to an individual teaching a class what should be part of his or her course, but there is tremendous diversity across courses (e.g. level of quantitative content, level of process discussion etc.). Maybe our choice of wording (confused self image) can be improved, but we certainly claim that our results suggest that there is no common curriculum for hydrology, which suggests that there is no consistent picture across courses.

On page 2330 line 17 it would be nice to refer to some articles in the special issue, or to the special issue as a whole. RESPONSE: Absolutely, we will do so in the revised version of this manuscript.

Page 2332, line 7 – 10. Hydrology as a subject in itself is not multi-disciplinary, but

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it can be part of a multi-disciplinary approach, such as IWRM or team (see quotation of Nash et al on page 2325). Line 11: so the integration should happen in an IWRM course, not in necessarily in a hydrological course. The educator should of course have knowledge on adjacent disciplines but does not have to be an expert. Also correct this on page 2333 line 16, 17. RESPONSE: Maybe multi-disciplinary is not the right term here. We do not claim that a hydrologist also has to be a soil scientist, a geologist, a meteorologist etc. However, we claim that hydrology educators often do have insufficient knowledge of other disciplines while having to include material from these scientific areas into their teaching material. Here we can see a lot of possible advancement if the material is developed jointly with experts from these areas in the first place (and updated by them in the future). This is the so-called T-shaped competency profile that we are looking for in a hydrologist (e.g. Uhlenbrook and de Jong, this issue). We will also emphasize the student more than the subject in this section. We suggest that a hydrology course should be taught with the perspective that the students often come from different disciplines or may work in an interdisciplinary environment.

Technical corrections: There are still many English language mistakes in the document, please correct that. In some instances very informal (American) English is used, such as on page 2335 line 8 “.. of like...”. Page 2339 line 8 and 9: this is not a correct sentence. Change to: ... Material should be provided, that ...” Writing in general should be more succinct. Examples: page 2343 line 11: “such project” I understand that you refer to the community-based framework in the lines before, so use the word framework instead of project. Also page 2343 line 8 “take a look into the future”: that is too imprecise for a scientific text. RESPONSE: We will review the English throughout and make the required improvements.

REVIEWER 2

The authors have identified the need for hydrologists to learn field and lab observation techniques, quantitative analytical methods to process data, and computational modeling methods to examine concepts and hypothesis. They note the call for this training

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has been made before (for example, Eagleson et al., in the 1991 National Academy Press), yet no single textbook or set of lecture notes has delivered the material to adequately train hydrology students. As such, many hydrology professors are spending significant time assembling instructional material to complement or supplement existing books and are not spending enough time developing appropriate pedagogical approaches to excite and achieve student learning. They recognize the field of hydrology has learned from other fields (sanitation) and had benefited from open source and shared data approaches (COMET, LINUX). They propose to use Modular Curriculum for Hydrologic Advancement (MOCHA) to harness these collaborative approaches and remedy the need for better instructional material.

These authors are a wonderful example of how to form a community – they are all at the top of their fields and prioritize finding time to work together and bring along the rest of the hydrology community. Their leadership in fieldwork, quantitative analysis, and computational modeling lends itself to developing fun exercises. My biggest need as a hydrology professor is not lecture notes but in-class, in-lab, and take-home exercises that tap into the real world applications these hydrology heroes and authors have tackled. RESPONSE: This is a very interesting comment by the reviewer. We certainly agree that having such exercises is a very important part of any hydrology course and that there can almost not be enough. We have ideas on how to focus on developing such exercises in future projects related to MOCHA, and have also supported other proposals that have the objective of developing them. However, we do find that there is a big difference in how useful the MOCHA teaching material is to instructors depending on the stage in their career. The original MOCHA idea was conceived while all the PIs were Assistant Professors or Postdocs. We agreed amongst ourselves that developing an initial course (that we were happy with) was potentially the biggest (and least recognized) time sink for our early career stages! Being provided with the material now would be less of an advantage, given that we all have established courses (though it would still be helpful for improving them).

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The issue of audience is possible unresolved. I was unclear whether the MOCHA based hydrology class was intended for engineering and non-engineering students – should both groups enroll in the same lecture. I ask because the authors stated engineering students would have had fluid mechanics as a pre-requisite, and that nonengineering students would not, but that a control volume approach would satisfy both sets of students. I am hopeful a singular course would work for both, but the nonengineering group could be broad, and include geologists, foresters, environmental chemists, etc. It is possible having the first (and often only) class in hydrology be the same for both populations of students may result in each population underserved. Would they be at a disadvantage compared to their disciplinary peers when applying to graduate school or performing research? It seems for engineers, after they complete fluid mechanics the engineering hydrology course should pick up on more complex pipe network problems and more complex open channel flow problems, to name a few topics. I see on lines 14-16 on page 2339 you are suggesting MOCHA slides have more material than needed so different amounts can be selected for different audiences. This seems appealing, but the implementation of this may be difficult (e.g, finding equivalent time to teach each audience, ensuring equivalent homework in each audience, the instructor having the training to handle questions for each audience). It would be great if you had a curriculum expert assess whether the audiences had equivalent learning when different in-depth versions of these MOCHA slides are used. RESPONSE: This is an excellent and very important point. We do believe that the same baseline material can be used to satisfy engineers as well as scientists (using the term for everybody who is not a engineer in a hydrology course). This is beyond the cope of our current work, but would be excellent to add at a later stage. We indeed have to do additional assessment at a later stage when more material (modules) is available. We have assessment and educational specialists as part of our MOCHA group, but there is more to be done.

Regardless of the targeted academic discipline for the MOCHA class there is a variety of learners and aptitudes. For example, if we teach engineering students only with the Brutsaert book, some will wither in the mathematics and not pursue let alone capture

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the excitement of field work, while others will revel and celebrate in the mathematics elegantly describing the system. Note to authors - a very good book balancing a systems perspectives and computational analysis not mentioned by the authors is by Wurbs and James, entitled Water Resources Engineering; there are similarly titled books by Chin and Maidment. RESPONSE: Absolutely. One of our objectives is to show students the holistic nature of hydrology and that it encompasses all of these aspects – and that they can all be fun! We are looking to create the Renaissance hydrologist or the Leonardo da Vinci of hydrology!

The MOCHA scale feature in the PPT slides seems like a helpful addition for students who are not able to see the forest for the trees. The problem may be the artificial boundaries of point, plot, and watershed. For a Global Circulation Model, it treats a degree unit of the earth as a point, like other lumped watershed models. As scale increases, do vertical balances change, or do lateral connectivity emerge? RESPONSE: Given that we were developing material for a watershed hydrology course, we stopped at the watershed scale. The separation is certainly not unambiguous in all cases, but we believe that it will work conceptually for most material. The scale icon can easily be tailored to an individual course where the instructor might prefer different classes.

The authors need to clarify what MOCHA lessons are available – from the website it seems you have 2 lessons. In Line 23, page 2337 you say, “All MOCHA modules include: : :”; perhaps you can say the 2 modules? This is rewarding to have 2, but until you have a full course ready it seems the students / faculty using this approach may experience the confusion of discontinuity (e.g., disorientation of moving between different format slides and textbooks and problems, having different terms presented for common phenomena, etc). I realize in Lines 5-10 on page 2339 you argue differently. RESPONSE: We did not want to make strong statements about this since we have several additional models that will likely be ready by the time this paper will be published. Others will follow later and any number listed in the paper would quickly be wrong. We have 2 initial modules at the moment, which we do believe can provide

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useful material for a lot of instructors. Our own preference would of course be to have a full MOCHA course. This is not yet the case, but it is just a question of time when we will have achieved this.

The development and use of the infiltration module is commendable. I realize the authors are concerned some hydrology concepts that are taught and in textbooks are out-dated, however engineers training to be a practitioners need to know the simple Curve Number model to pass the FE / PE exams and comply with local ordinances. While we need students to know a Green Ampt or Richards Eqn solution to deal with initial abstractions for intense and short duration rainfall events, the Curve Number approach is robust for the applications it undertakes. RESPONSE: We agree with the reviewer that certain concepts should be taught even if they are not physically realistic. CN should certainly be discussed given their widespread use in practice. We mainly claim that the presentation of such concepts has to include a discussion of their applicability, assumptions and limitations. The latter is what is often missing from textbooks. Especially engineering hydrology textbooks leave out a discussion of the underlying processes that are or are not well represented. Regarding the specific issue of including CN in our module. I think that a lot of users will use this module over more than one week and expand on the material presented. We might actually add an infiltration 2 module later to accommodate that there is a lot more to be said. This would then also include the CN approach. We are not suggesting that CN is not relevant and should not be taught!

Some errors: Line 11 on page 2336 “to students are more restricted” seems to miss “who”? Line 12 on page 2336 “is not need”, perhaps use “no”. RESPONSE: We will make language corrections throughout the paper.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 2321, 2012.