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Hydrology and Earth System Sciences Discussions



# *Interactive comment on* "Engaging the students of today and preparing the catchment hydrologists of tomorrow: student-centered approaches in hydrology education" *by* I. Ngambeki et al.

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Forgive the "intrusion" by somebody outside of the field (from the world of research in science education, particularly chemistry education), brought about by an acquaintanceship with one of the authors (S.E.T.). This is an excellent paper that summarises and analyses current educational trends, their advantages and disadvantages, and issues to be considered in relation to implementation. Although it is largely based on extrapolations from research in other areas of education, qualitative evaluation of tried innovations, and even opinion, it is at very least a valuable basis for discussion. The

notion of PCK is obviously important: in my own field, for example, the specifics of productive ways of teaching about entropy are necessarily different from useful ways of teaching about chirality of molecules. The teaching approaches we use must necessarily take account of the specifics of the knowledge and skills taught to be effective. A few points of detail follow. I hope they are not overly pontification. I would beware use of the term “information processing theory” in the sense that it is used at the bottom of page 414, because it could well be confused with the “information processing model of learning”, perhaps best described by A.H. Johnstone (Journal of Chemical Education, 74, 1997, 262). While this model does not pretend to imitate machine-like operation during learning, its consideration of how we react to incoming sensory inputs (what we hear, see, feel, smell and taste) can be useful to contemplate the reasons behind some observations about teaching and learning, such as selectivity of input stimuli, information overload, language issues, ‘chunking’ of information, students’ reduction of new knowledge to a habitual level, and so on. The rather traditional view of teaching implied in this paper (yes, sometimes also referred to as ‘information processing’) might be better called information transmission, didacticism, instruction, cumulative topping-up, or simply chalk-and-talk. It is based on a view that knowledge is absolute, and independent of the backgrounds, prior knowledge, motivations of the learner, and intended use of the knowledge. The trend toward constructivist approaches (there are a range of them) grew out of a massive, but rather stamp-collecting, phase of science education research that clearly demonstrates that traditional assessment procedures hide grave misconceptions (or alternative conceptions) held even by students who are successful in our traditional exam-oriented curricula. For a tiny, but significant example, see the video "A Private Universe", created and produced by Matthew H. Schneps and Philip M. Sadler, Harvard Smithsonian Center for Astrophysics (A PRIVATE UNIVERSE 18 Minutes, VHS, 2004, Pyramid Media, 2801 Colorado Avenue, Santa Monica, CA 90404, 310-828-9083). The misconceptions of Harvard physics and astronomy graduates about the seasons and the phases of the moon is gob-smacking. There is an industry of research in exposing students’ inadequate understandings, which has



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led to scholarly journals, books, networks, and conferences, as in any other academic research endeavour. In bringing together discovery learning, learner-centred activities, interactive learning, one can hardly ignore a movement known as POGIL (Process Oriented Guided Inquiry Learning http://www.pogil.org/). It is particularly good in the context of use of "clickers" (student response systems, or personal response systems) which require students in large classes (individually or in small groups) to commit to an answer/prediction. This commitment can lead to enhanced confidence and motivation (in the case of 'good' answers) or recognition of a need for questioning and clarification if commitment has been made to a poor answer. A simple case from chemistry derives from an in-class question "Which of the following solutions (choice A, B, C or D) do you think has the lowest pH?" Students press the buttons on their clickers, and lecturer has immediate access to responses (say, 29% A, 18% B, 23 % C and 30% C). Pretty scrambled and random. "OK, now meet in your groups and defend your choices. In the course of a few minutes, students try to convince others - but are perhaps convinced by the logic of others, and recognise flaws in their understandings. Asked for another commitment, the choices might be 5%A, 2% B, 93% C (correct) and 0% D. Learning has occurred, largely by social constructivism. One of many descriptive websites is http://www.cwsei.ubc.ca/resources/clickers.htm. Some research documentation, as well as personal experience, tells us that we should be aware that implementation of learner-centred teaching models can require a change of student attitude. There are examples of near-riots around the student demand "You are supposed to be doing the work to teach me, but in fact you sit down and expect us to do the work!" In addition, there are issues to be faced if a student attends traditional lectures on statistics at 9 am, and on energy at 10 am, as a listener, and then is expected to transform to an active doer/learner in the catchment hydrology class at 11 am. Since different learning approaches might be used to maximise learning of particular sorts, assessment methods need to be modified to reflect the new intended outcomes. In the Conclusion, at the bottom of page 728, is the statement "However significant questions remain." This leads to excellent questions that should encourage research into hydrology edu-



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cation. One of the most significant values of such research can be the documentation of knowledge about teaching and learning in hydrology. Without documented research, the knowledge of instructors gained through experience (PCK) is lost with the retirement of each of them, and novice instructors begin the cumulative process anew. This has been referred to as repetitive “professional amnesia”. The scholarship of teaching and learning in hydrology (or in any other discipline) deserves the same value as the scholarship of hydrology itself, or chemistry, or any other field of knowledge discovery.

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