**Energy Sources and Earth Processes: Follow-up Detailed Comments**

Detailed comments

**Overarching Goals**

**Comments:**

Technically, this module meets the goals for the InTeGrate project but seems to somewhat miss in the spirit of the project. In essence, the project is not exciting and will not motivate learners because it does not focus front and center on the grand challenges facing society; rather, it hints at them from the sidelines. The approach is traditional (starting with first principles rather than the big questions) with too little framing that excites learners about geoscience's big ideas and society's grand challenges. Learners, and especially science-phobic ones need to know why learning science (which is hard) is important. Further, if the target audience is science-phobic teachers, it is especially important to teach them in new and novel ways because they will mimic what and how they learned in their classrooms. I suggest opening each activity with a grand challenge or big question framed around "how do we figure this out" and then use the introductory narrative text to excite learners about what a few simple investigations can tell them about the Earth.

Flip the sequencing to place relevancy first and foremost and use this to engage students. Why do we care? What’s the point? Questions like this will motivate students to work through the materials.

**Learning Objectives and Outcomes**

Again, the authors have done an incredible job to tie together learning outcomes and focus those on the tasks of the module. The issue that I see is not in this arena, but in the communication of those outcomes to learners. The text throughout all three modules could be simplified significantly. I think the message is there but the text needs to be revised significantly to match the level of introductory students. It is to hard for introductory students to decipher as it currently reads and as such, the message is lost. There also appears to be some confusion between goals (broad and not assessable) learning objectives (focused and assessable--"understanding" is not assessable) and learning outcomes (assessable against results from an assessment vehicle). This needs clarification in all documents, especially if the future teachers are the focus.

**Assessment and Measurement**

Assessments and formative and summative. The formative commonly ask faculty to observe student behaviors according to a few criteria. I suggest including at least one concrete activity that facilitators can physically review prior to any summative assessment.

**Resources and Materials**

Some of the figures looked like they were from older textbooks (not that I think this is a problem as long as the information in the figure is correct).

ssEd by the ideas of the interconnectedness of concepts, they will be more likely to

The activities need a roadmap that learners can embrace. Although each activity lists learning goals, generally they are not goals that learners will buy into. As the authors read through the text, they need to put themselves more firmly in the shoes of the science-phobic future teacher who is desperate for a really, really, really compelling reason for why they need to know how to think this way and why it is important that their future students embrace similar ways of seeing and living with the Earth. Throughout the narrative and several activities, sentences are long and wordy and would benefit greatly from editing and tightening of language. There are also missing words and grammatical errors that will lead to conceptual errors. Shorten and focus sentences using clear and concise action verbs, but use real verbs ("whiteboard" is a noun, not a verb).

**Instructional Strategies**

**Comments:**

The authors have done a good job in creating a wide range of activities that will engage students in learning about the hydrologic cycle, but their instructional link to energy transfer processes is a bit weaker. There also are few opportunities to quantify results using real data that directly link to a big issue. For example, the activities that look at flooding could be made more compelling by looking at human induced floods by concentrating on a recent flood that received national attention. In most cases, gathering stream runoff data from minor events that preceded the Big Flood clearly demonstrate where flooding will occur. During minor events, contrasting river levels in areas with very different runoff rates (e.g., forested, farmed, and urban areas) in the same drainage system can predict where flooding will occur during a 100-year event. The data are usually clear, but sadly, this is where geoscientists usually stop. Might it not be more important and effective to open the conversation to the economic costs of mitigating for 100 year events? The same thinking applies, just this time the numbers are economic. Then the science becomes part of the broader conversation and is not locked in the drawer called Geology 101.

**Alignment**

I see that while activities 1, 2, and 4 have clear links to societal implications (availability of freshwater resources, alteration of river systems by human activity, and flooding hazards), activities 3 and 5 focus primarily on the geological concepts and do not have explicit ties to the societal implications like the others do.

**Overall Comments**

I really liked the content of this module. The authors do a great job of varying the instructional methods with incorporating experiments conducted by students, analysis of real-world data, and observations via Google Earth. It was clear how each activity related to/built upon one another. If explicit links to societal issues is required in all module activities, my only suggestion would be to infuse a bit more of that content into Activities 3 and 5. While Activity 3 does a nice job having students compare and contrast the two river systems, perhaps it could add a couple more questions that pertain to the flooding hazards of those two rivers.

The authors have chosen a marvelous topic to address most of the ES literacy Big Ideas, but they need to herald those ideas loudly to learners in language the learners can embrace. To do so, begin with the big idea and translate it to an activity. Frame the idea as a statement or question, but in each case, ask the follow-up question, "How do we figure this out?" and proceed to challenge the learner to do so with the scaffolding need to support their inquiry. This task will be far easier for learners if the destination is clear and exciting, the roadmap they follow uses clear, concise, and jargon-minimized language, and effective checkpoints for self-assessment are provided along the way.