

Observing Students Revise their Conceptual Understanding Through Revision of Writing

Robert Dalka* and Timothy McKay

Physics Department, University of Michigan, Ann Arbor, MI 48109, USA

**rpdalka@umich.edu*

Course Context – Introduction to Mechanics

- Calculus based, introduction to mechanics
- 600+ students enroll each semester
- 3 sections taught in both Fall 2018 and Winter 2019 terms
 - 2 taught by a senior lecturer
 - 1 taught by a tenured faculty member
 - Instructional team coordinates between all sections

Writing-to-Learn at Scale? M-Write



- Writing-to-Learn is well founded in educational theory.
- The M-Write initiative brings WTL into STEM courses at the University of Michigan
- Writing Fellows are trained in WTL pedagogy and help the instructional team to oversee the activities.

J. Emig, *Writing as a mode of learning*, College composition and communication (1977).

M-Write, <https://lsa.umich.edu/sweetland/m-write.html> Retrieved 6/12/2019.

Three “Layers”

Researching the Process

Evaluating Students

Viable Activity

Identifying Student Confusion

- Able to find spots of student confusion
 - Peer evaluations with guided questions
 - Writing Fellows reading submissions for grades
 - Researchers investigating activities
 - etc...
- Example of an identified area of confusion:
 - Selecting entities to include in energy systems and the relation to potential energy

The Activity - Energy Storage by Pumped Water

- **For a successful M-Write activity,**
 - Tangible scenario/ setting
 - Student role
 - Specific audience
 - Clear learning goal

“Understanding the importance of defining an energy system and how to choose the entities to include in it.”

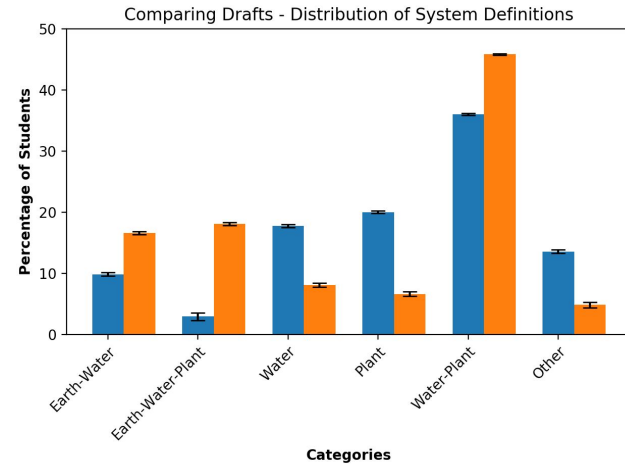


System Definitions

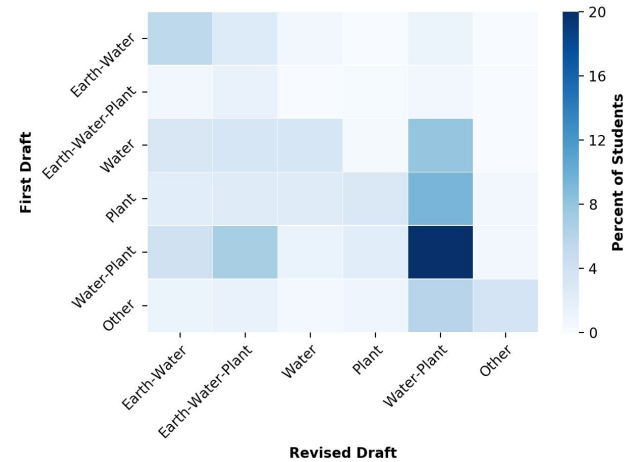
- **Earth and Water**
 - “The system we are working with is in reference to the mass of the water and the Earth as a whole unit.” – Student 227, First Draft
- **Earth, Water and Plant**
 - “We can define the system that the energy is flowing into and out of as the Earth, the water, the reservoir, and the turbines.” – Student 375, First Draft
- **Water**
 - “The system that the energy flows in and out of is the lake water itself.” – Student 155, Revised Draft
- **Plant**
 - “When they referred to an energy system, they were talking about how their system converts energy to help their needs, in this case electricity.” – Student 391, First Draft
- **Water and Plant**
 - “Let me start with defining the system that your example refers to. The system relates the bodies water and the turbines.” – Student 27, Revised Draft
- **Other**

Students' Responses - Fall 2018

N = 620

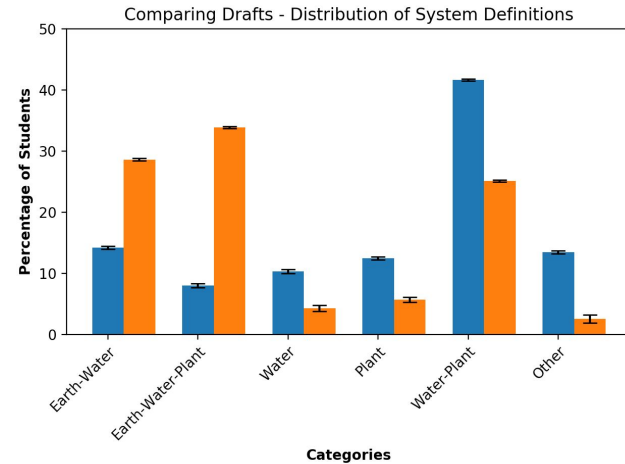


■ First Draft
■ Revised Draft

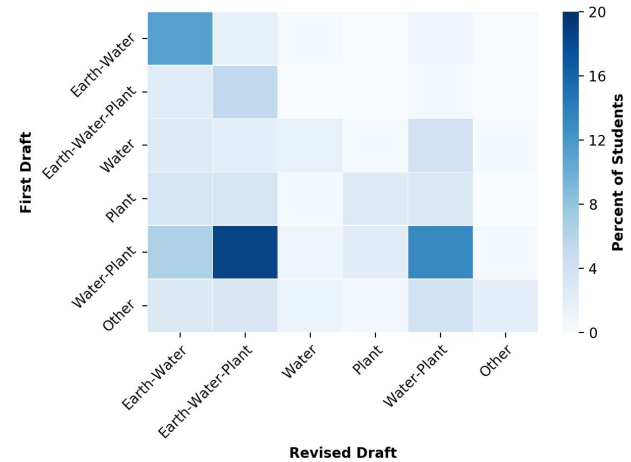


Students' Responses - Winter 2019

N = 514



■ First Draft
■ Revised Draft



Summary

- Our implementation of Writing-to-Learn
 - Peer Review system
 - Grading with Writing Fellows
 - Researching the process
- Able to identify difficult topics for students
 - Goes deeper than a multiple choice question
- I think other practitioners and researchers should try similar activities in their own classrooms

Thank you!



rpalka@umich.edu

Prompt

MWrite Prompt 2: A Watershed Moment in Energy Storage

You are a consultant working at a renewable energy consulting firm here in Ann Arbor. Your firm works with companies such as DTE and Consumers Energy to help create more renewable and sustainable energy projects around Michigan.

Your boss, Mr. Green, is a marketing wiz, but is not always up to speed on the technical side of the projects. He is on a visit of the Ludington Pumped Storage Plant. He sends you an email saying that it is going well and shares with you an MLive article from 2011, discussing the 6-year upgrade project that increased the efficiency of the plant (see attached pages if link does not work). Mr. Green is pretty sure that your firm would be able to oversee and advise on the construction of a project that would be very similar to the Ludington Pumped Storage Plant, but he is unsure on how the system completely works.

Later that day, you get a call from Mr. Green.

"Hey, this place is really cool, we should definitely send you out here sometime. Anyway, the reason I called is because while the team here has been great at going over the logistics and, like, the financial aspects of this place, they haven't really gotten all that technical with me, maybe they don't think I'll understand?"

Who knows, but I was wondering if you could have a memo, or something, memo would probably be good. If you could have a memo ready for me when I get back tomorrow. Could ya go over some of the physics behind this sort of facility? I really want to know where this energy is coming from, I mean, I know it's off the grid, but that's electricity. How is that supposed to lift the water in the first place, and where does it go after? Is this the 'moving between systems' thing you were talking about the other day?"

They keep telling me that the energy is stored in this water and the energy system, but what does that even mean? What is the system they are talking about? Then they said the energy could be uh, I think they said 'lost'? How does this happen, does it like, leak out of the water? I've never seen energy leaking out of water. And lost? Where does it go? Last week you were going on and on about how energy couldn't be created or destroyed, but they are telling me they lost this energy and its now gone? Were you serious about that energy conservation stuff, what's going on here?"

I do really like this place though, it's really nice. Do you think that this is something that is uh, that is sensible for state of Michigan to store energy elsewhere in the state? Where do you think these kind of facilities would work the best?"

Hope that's not too much. I'd really appreciate it if you could do this for me."

You reply that you will be able to draft a memo that answers all of his questions about the process while explaining the physics behind it. Mr. Green thanks you and hangs up the phone.

In your report be sure to...

- Define the system that the energy is flowing into and out of
- Describe the energy transfers that occur while the water is moving in the system
- Address Mr. Green's concerns about the 'loss' of energy, explain how this is consistent with the Conservation of Energy
- Close your report with your judgement of whether this type of project is physically and ecologically sound and where these projects would work best.

Keep in mind...

- Make sure to convey your physics understanding clearly and precisely
- Do not include your name (to preserve anonymity for peer reviews)
- Stay within 300-500 words
- Write your response to resemble the body of a memo
- Use an appropriate tone of voice for your role and audience
- Outside sources are not needed, but if used, please cite them in a citation style of your choice

Example Student Response

TO: Mr. Green

FROM:

SUBJECT: Water Reservoir "Battery"

Thank you for your request! This is certainly an interesting topic, as well as method for producing and storing energy. It is also clean and affordable. It works using basic principles of potential energy and kinetic energy conversion.

The system is the reservoir, the turbines, and the Earth. When the water begins the process at the top of the system in the reservoir, it holds gravitational potential energy because of its position. Its height means that gravity has the potential to do work on it. When the water is released, it naturally flows downward, into the lake, through the turbines. As it moves downhill, the height is decreasing. Gravity is doing negative work on the water from the frame of reference of outside of the system, converting the potential energy into kinetic energy (energy associated with velocity). As it flows through the turbines, some of the kinetic energy is transferred to the turbines, eventually converting to electrical energy. The water then continues to flow into the lake, before it is pumped back uphill using electricity converted to kinetic energy into the reservoir, converting its energy back into potential energy, where the process starts all over.

The energy is not visible. It is simply a matter of its position and state of motion. While the water is up in the reservoir, it has potential energy due to it having the potential to be pulled downhill by gravity. When the water is moving, it has energy associated with its motion. When the water moves through the turbines, some kinetic energy is transferred to the turbines, which later becomes converted to electrical energy. I believe by energy "loss", you mean inefficiencies in the system, causing some energy to be transformed into non-useful energy. Energy does not leak out of the water, rather it becomes converted to other types of energy. Some energy could be transformed to heat energy through friction and inefficiencies in the turbines. Energy can never be truly lost, as the Law of Conservation of Energy states that energy can only be transformed.

I do see an ecological and economical problem with this project. While this specific station uses water, which is clean, to generate electricity, it also requires electricity to pump the water back uphill. This presents a problem, in conjunction with the fact that no system is ever perfectly efficient. Economically, the fact that they pump the water back uphill at night, when electricity is not in high demand is a good idea. This seems to be a money-saving tactic and nothing more, since they still use the same amount of electricity to pump the water uphill. Time will tell if my concerns are valid.

In order for this type of system to work, they must have a location where they have elevation. This system relies on water being able to flow downhill, which is only possible with elevation. Along the coasts of the Great Lakes, in spots where there are hills, cliffs, or other elevated landforms is where this type of system would work best. Additionally, the location must be able to hold as much water as possible, in order to have the most possible mass of water to transform between potential and kinetic energy. I question how this would affect the local wildlife, but should not present too much of an issue. It should be a goal of the company to minimize any pollution to the lake and surrounding area.

Thanks again for your request, I hope this provided sufficient insight as to how this plant works.

Our Structure

