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Paper Topic #3
Waste from Teaching Labs on the UW Campus

Waste management on the University of Washington campus is important because the university should serve as an example to the rest of the community. As an educational institution, the practices of the university could be emulated around the Seattle area. The UW has been recognized as an environmental campus. Education is a costly resource that students and the state government pays for. But just as with waste in general, we don't pay the price for the amount of waste we produce. Each American produces about 1600 pounds of waste a year. I suspect that the cost of disposal is much higher than what we pay for, in terms of waste management collection and disposal. Land is required to store the waste, treatment facilities are required, and personnel need to be hired. In addition, damage to the environment from the amount of toxic waste produced has an extremely high price for humanity. This is the reason that Americans continue to create so much waste; we don't really pay the price for how much we produce.

I have not seen professors or university officials address the amount of waste produced in the process of education. A lot of waste is produced in the process of teaching, from books and paper to electricity that is supplied to classrooms. In America, we put a high value on education but I think we must be critical about the true benefits and costs. I would like to examine the waste produced in teaching labs on campus and try to compare the costs and benefits. This type of waste is considered an acceptable sacrifice for the sake of education and hands-on experience, but I suspect that waste produced may exceed the acceptable amount of waste expected. This is especially relevant because hazardous waste that is disposed of improperly, or even properly, can be very dangerous to human health and environmental health. Harmful chemicals can leak into groundwater. Certain chemical compounds that are flushed into natural bodies of water can

disrupt the chemical composition of ecosystems. Laboratory protocols, especially in chemistry, produce a lot of these harmful chemicals like acids, nitrates, and flammable organics.

In my experiment I would pick one course that has a weekly lab and I would compare actual with expected amount of waste produced. If experiments are producing an excessive amount of waste, this needs to be measured and addressed. The reason for this question is to assure that the university, in its goal of educating students, is not inadvertently producing an excess amount of waste and harming the planet. Overall, education and the university is supposed to improve the world and come up with new technologies, so we need to address the possibility of harm done to the environment from education. I would need to collaborate with the professor and teaching assistants for the lab. It would be best to run the experiment for the entire quarter rather than for each lab protocol. This way, there would be less chance for error. The experiment would start before the start of the course. I would talk with the professor, or the departmental director who designed and instituted the lab protocols. Together we would establish the amount of waste that should be reasonably produced by each class. For example, for an organic chemistry course, I would determine the volume of acidic/basic waste, the volume of acetone waste, and the volume of non-polar waste. These three bottles are available in the lab for students to separate their liquid waste safely. Solid wastes like organic compounds need to be disposed of separately from solid waste like latex gloves and paper towels. In addition, some labs produce glass waste from pipettes. Solid waste and liquid waste would also be weighed.

After establishing the amount of each type of waste that is reasonably expected to be produced, the next step is to collect and measure waste. I would empty all the waste receptacles before class and collect all waste after students are finished. Then I would obtain weight and volume for all separate types of waste (liquid, solid, hazardous, etc.). At this point, I could begin

comparing and analyzing the amounts of waste only. However, I still need to establish what excess waste means in terms of measurement and costs. I would consult with the Department of Environmental Health and Safety at the UW to establish the cost of waste disposal.

Hazardous materials, especially those produced in organic chemistry labs like hydrochloric acid, ether, or acetone are hazardous to the environment so they require special handling. This is costly because this waste needs to be properly neutralized and disposed of separately from regular waste for safety and protection. Regular waste is also costly to transport and dispose of. Some bio-hazardous waste needs to be autoclaved to kill harmful bacteria – this consumes water and electricity. Disposal and handling of lab waste also requires paying employees to properly dispose of waste. Teaching assistants need to be trained in special protocols for waste disposal – another cost. All of these details likely cost more than the lab fees that students pay when they enroll.

This experiment would itself have costs as well. Most of this cost is time – researchers or teaching assistants need to have the time to measure and collect the waste. The researchers would have to be educated on how to handle hazardous waste and would need to be provided with protective goggles, lab coats, and gloves just like students in labs are required to use. If I were to conduct this experiment for Organic Chemistry lab (Chem 242) in Autumn 2012, I would have about 144 students and six laboratory sections. I estimate that it would take ten to twenty hours to establish the expected amount of waste by meeting with professors and researching the lab protocols. I estimate it would take two hours to collect and measure waste per lab section. Lab meets twice a week, so this means there are twelve lab meetings total. This translates to around 24 hours of labor per week to collect and measure waste. Costs would also include space to

actually collect and measure waste. There would need to be a temporary place where waste could be stored before it is ready to be disposed of via the normal disposal protocol.

At the end of the quarter I would have two sets of numbers to compare – the amount of waste expected and the amount of waste collected. I would have established a rough cost (based on research collected from the University's Facility Services and Environmental Health and Safety Department) of the cost of waste disposal for the expected amount of waste. First of all, I would need to establish if this expected cost is worth the benefit of the lab. This is beyond the scope of this paper. It is a very theoretical and subjective question. I would need to do a literature review on the educational research that supports teaching labs. I could also talk to experts in science education to understand academic benefits of hands on experience. Now I could compare cost and benefit roughly; but it is more important to compare what is expected and what is the real outcome. This assumes that the university has taken into account the cost of laboratory waste and has concluded that it is worth the teaching benefit. However, my main goal would be to make the university aware if there is an excessive amount of waste being produced. If so, I would theoretically also be able to assign a cost for this excessive amount of waste.

This information would be useful for the departmental lab advisors and professors who design course requirements. If professors, teaching assistants, departmental chairs, the lab director of the chemistry department, or the chemistry stockroom director were aware of unnecessary waste produced in teaching labs, they may alter their lab protocols or requirements to reduce the amount of waste. Further research and investigation is required to understand why there is excess waste. There could be many reasons for excess waste – it could be that the lab protocol requires too much equipment or students are misusing lab equipment. Students may not have the skills require to efficiently perform lab protocols or teaching assistants might be failing

to monitor the use of lab materials. Perhaps students should be assigned a limited amount of material for each lab. I could write up my results in a short summary and then send a letter to professors and lab managers so that they could read some of my recommendations for change. First, this experiment could simply raise awareness of excess waste being produced on campus. However, simply telling people that excess waste is produced is not enough. It is also important to assign a cost to this excess waste – this would get the attention of university officials who are concerned about the budget. I would need to plan more experiments to actually see why excess waste is produced how it could be reduced. This requires more experiments, talking with people in various departments from Environmental Health and Safety to the financial directors of each department.