

Assessing Global Awareness in Associate Level Microbiology: Adapting Case Studies and the AAC&U VALUE Rubrics to Examine the Global Challenges of Mosquito Borne Disease

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Abstract: A process for adapting a case study as a high impact practice for undergraduate microbiology classes is described and its use in assessing global awareness as an institutional outcome at the course level. Documenting the student learning of content objectives and retention is addressed. Four student artifacts are assessed with an adaption of American Association of Colleges & Universities (AAC&U) rubrics at various points in the unit for formative and summative assessment. Student attrition, critical thinking, global awareness, and engagement in biology are addressed.

Introduction

In incorporating global awareness as a college learning outcome in community college microbiology classes, we had several considerations in using a case study from the International Union of Biological Sciences and the AAC&U VALUE Rubrics to assess learning. While we were concerned with highlighting global awareness, we were likewise concerned about content objectives and retention. Attrition from college STEM majors generally occurs in the first two years. The attrition rates in college STEM majors are 48% for baccalaureate degree programs and 69% for associate degree programs nationally (Chen & Soldner, 2013); and in one study, attrition for advanced microbiology majors was 30% if students stayed past the first couple of years (Margulies & Ghent, 2005). At our college, we average nearly 50% attrition in science classes.

In response to these alarming numbers, diagnosing the reasons for attrition and mitigating them have consumed teachers and

researchers over the last several years given the vital need for STEM professionals globally and nationally (Seymour et al., 1997; Verdartham, 2017). Active learning in STEM classes early in a student's program has been identified as one of the most important factors in engaging and retaining students (Freeman et al., 2011; Freeman et al., 2014; Burrowes, 2003). High impact practices lead the way in making learning accessible and meaningful across diverse student demographics (Kuh, 2008).

However, there is an understandable bias for biology instructors who assume that because students do lab work, that this is the active learning portion of the course. Labs do allow students *to act* like scientists, yet active content acquisition allows students *to think* like scientists. What science faculty cannot overlook is that active learning must take place during content acquisition through developing their critical thinking and metacognitive skills because this is where their scientific identities are built.

When students see themselves as scientists, they tend to stay as STEM majors.

Therefore, adapting an engaging, scaffolded assignment along with emphasizing a college learning outcome was challenging. We needed to employ associate degree leveling in adapting the college learning outcome with the learning objectives for the assignment and create a corresponding rubric to measure global awareness. Although we could incorporate the outcome assessment with the grading rubric to create meaningful data, additionally, a pre-test gauged students' initial global awareness, content knowledge, and metacognitive awareness while a post-test measured student gains through the administration of a brief questionnaire for the unit. We also included a self-reflection as a piece of the assessment process.

Adapting Learning Objectives of a High Impact Practice Case Study

We adapted a case study, "The Challenges of Mosquitoes and Disease: Making Sense of Complexity" from *Global Health Has No Barriers*, by the International Union of Biological Sciences (IUBS), July 2011. The case study has an Introduction, Investigations 1, 2, and 3 with targeted questions.

Case studies are high impact practices as it takes knowledge into a real-world context. We chose this case because it highlights global awareness. Using Bloom's taxonomy, we adjusted the learning objectives which were assessed by rubric during the group assignment:

- Students will define vector borne diseases.
- Students will recognize the importance of vector borne disease in a global context.
- Students will compare endemic and pandemic diseases in a global context.

- Student will differentiate between the various health risks of acquiring a disease in a specific global region.
- Students will evaluate the potential benefit of medical and public health strategies for reducing the impact of the disease in the global region.

Using our learning objectives and definition of global awareness, our adapted learning outcomes for this assignment were:

- Students will demonstrate integration of their knowledge and skills by engaging with and responding to environmental and economic challenges at local, national, or global levels.
- Students will identify an economic, environmental or public health challenge spanning countries or cultures and presents evidence of the challenge.

Adapting AAC&U VALUE Rubrics to the Associate Level

The AAC&U VALUE Rubrics are leveled for outcomes at the completion of the baccalaureate degree. They are nationally normed and were written with a robust cross-section of faculty across the nation. We used the two AAC&U VALUE rubrics most closely related to our college learning outcome of global awareness—"Intercultural Knowledge and Competence" and "Global Learning" (AAC&U, 2009). As we began adjusting for the associate level, we removed the "Capstone" achievement level from the original rubrics with the assumption that our students would not have developed to that degree after two years. We also took those line items that most closely aligned with our definition of global awareness and described the behaviors of students at each level in Table 1.

Table 1. <i>Adapted AAC&U VALUE Rubric</i>	
Proficient 5	Criteria: The response demonstrates a <u>thorough understanding</u> of a specific environmental and public health challenge spanning geographic and cultural regions and presents evidence of the challenge. Student can evaluate the potential benefit of medical and public health strategies for reducing the impact of the disease in five global regions. (Description of Investigation 3 and Question for investigation 3 using reports from UNICEF, WHO and UN to compare the control strategies from five global regions specified in the case study)
Mostly Developed 4	Criteria: The response demonstrates a <u>complete understanding</u> of the role of environmental and public health challenge spanning geographic regions and presents evidence of the challenge. Student can differentiate between the various health risks of acquiring a disease in a specific global region. (Description of Investigation 2 answer the five specific questions on strategies)
Developing 3	Criteria: The responses demonstrate a <u>partial understanding</u> of the role environmental and public health challenge spanning geographic regions and presents evidence of the challenge. Students will be able to compare endemic and pandemic diseases in a global context (Questions for Investigation 1 and Fill the table completely)
Novice 2	Criteria: The response provides an answer that contains <u>minimal understanding</u> of the role of environmental and public health challenge spanning geographic regions and presents evidence of the challenge. Students will be able to recognize the importance of vector borne disease in a global context. (Description of Investigation 1 and learn about the five diseases that are global in context)
Poor 1	Criteria: The response provides an answer that contains work that shows <u>little to no understanding</u> of the role of environmental and public health challenge spanning geographic regions and presents evidence of the challenge. Students will be able to define vector borne diseases in a global context. (Description of the introduction to the case study)
Unacceptable 0	Criteria: The responses provide insufficient evidence to demonstrate <u>any understanding</u> of environmental and public health challenge spanning geographic regions and presents no evidence of the challenge. Student can define vector borne disease but are not able to visualize or recognize the interconnectedness in a global context. (Description of the textbook definitions of vector borne disease without a global context)

Note: *This rubric was created using the Association of American Colleges and Universities (AAC&U) Intercultural Knowledge and Competence VALUE Rubric and Global Learning VALUE Rubric.*
<https://www.aacu.org/value-rubrics>

We also consulted the Degree Qualifications Profile (DQP) Outcomes for category five: “Civic and Global Learning for the Associate Level” (Lumina Foundation, 2014). We identified one DQP outcome: “Identifies an economic, environmental or public health challenge spanning countries, continents or cultures, presents evidence for the challenge, and takes a position on it.” This dovetailed nicely with our college’s definition of global awareness and the college learning outcome: “Describe the interconnectedness of issues, trends and systems using diverse perspectives.

Methodology

Pre-Test (Setting the Stage for Learning)

The adapted case study was used in a microbiology classroom with 48 students, of which 39 students completed all four artifacts scored. We used a pre-test to determine baseline knowledge and for students to use as an anticipation guide much like the type of guides used in reading classes.

We administered the Pre-test using three questions asking for brief explanations from each student. They were:

1. (Global perspective knowledge): I can explain the sources of my own perspectives on Global health disease such as malaria in three countries outside the United States.

Circle One: Agree OR Disagree | Explain Why

2. (Ability to access information): I can investigate the nature of the health systems for the global health disease such as malaria in two countries outside of the United States with an understanding of the cultural perspectives.

Circle One: Agree OR Disagree | Explain Why

3. (Problem solving): I can explain how the knowledge from different cultural perspectives of disease burden might affect the risk factors and possible solutions to the global health problem in malaria.

Circle One: Agree OR Disagree | Explain Why

Using the rubric, we scored student responses to determine what they already knew and could do with their scientific knowledge situated in their cultural awareness. In the table below, students did not score well on any of the three questions leaving the instructor with little pre-formed opinions or misinformation to dispel and almost wide-open territory for content acquisition.

Table 2.

Pre-Test Results of Responses to Questions (N=48)



Assignment Sequence (The Learning)

The students were first introduced to the topic of vector borne diseases and to the connection between the prevalence of vector borne disease and history of eradication efforts in the Americas. The unit was spaced over 4-6 weeks dependent on school calendar and weather.

Investigation 1: Determining the cause of infection, signs and symptoms and use of epidemiology to identify possible mosquito vector borne diseases.

Investigation 2: Malaria and its control: Ecological, physiological and behavioral complexity.

Investigation 3: Controlling Malaria worldwide from the lens of Tanzania and Vietnam.

Rubric Applied To Group Work (Assessing the Learning)

After a classroom multimedia presentation and relevant content readings, we divided the class into groups of four to foster collaboration and group work for each of the case study's investigations via the POGIL method (Process Oriented Guided Inquiry Learning) to allocate student roles for each group (<https://pogil.org>;

Moog & Spencer, 2008). The POGIL methodology has been found to be especially effective as a pedagogy in science classes (Walker & Warfa, 2017). Each student was assigned a role from the following: the Facilitator kept the group on task and on schedule, the Quality Controller wrote accurate notes from each participant, the Spokesperson presented ideas, and the Strategy Analyst analyzed the written notes. At the beginning of each investigation question, students in each group spent a few minutes discussing their understanding of the resources using self- prepared notecards.

After completion of each investigation, each group reported out a concept map they had constructed on a whiteboard using common key terms followed by a class discussion. Students had the opportunity to explore each group's concept map. Each investigation took 50, 60, and 75 minutes respectively to complete, including reporting, discussion, and creating concept maps.

Students were assessed for the learning in each investigation through group work in their assigned roles. The rubric was applied to the groups' concept maps to complete this

assessment. Students were *Proficient* if they could differentiate and evaluate the potential benefit of public strategies in addition to the other categorical abilities. Students were designated as *Mostly Developed* if they could differentiate with the health risks while comparing the diseases globally in addition to the following categorical abilities. Students were *Developing* if they were able to compare the diseases globally and wrote correct facts about vector borne diseases. Students were designated as *Novice* if they wrote correct facts about vector borne diseases. We also differentiated between *Poor* and *Unacceptable* to better describe what a student could and could not do at the college level. While both categories indicated need for tutoring, both instructors and tutors had a more precise description of the deficiencies.

To enhance student metacognitive skills, we also asked them to write personal reflections on the inquiry process. After completion of the unit in class, students completed personal reflections for 30 minutes that were submitted via a discussion board hosted on the Blackboard learning management system. We used our adapted rubric to score these reflections as well because they also provided insight on their knowledge acquisition on mosquito born disease while allowing students to demonstrate their global awareness as they understood the successes or failures of mitigation of malaria in cultural contexts.

To illustrate some of the responses and how they were categorized, here is an **Unacceptable** response: *"I've known a little about the topic, so it wasn't a shock to me. It's just disappointing that places have to deal with the issue. Living in high tempature [sic] is one thing, but needing to deal with it because of money is wrong & shouldn't happen ever."* Since this is the totality of the response, it is difficult to gage just how much the student knows about the disease

although there is some recognition of economic factors.

A response at the **Novice** level relates: *"As ignorant as it may sound, I honestly did not know what malaria was. While reading this article there were many things I found interesting, even the fact that there are many kinds of mosquitoes...countries with little or no resources are the ones that are more at risk with diseases like Malaria. After reading this article, I truly believe more people should take the time and familiarize themselves with diseases that are common not only in their location but as well other locations, especially if they travel often."* This student has a little more information about the causes of the disease without details and gives us an exhortation to learn about other locations but, again, without contextualizing their knowledge.

A response categorized as **Mostly Developed** states: *"After the case study, I learned that malaria is caused by plasmodium parasites, and it is from anopheles mosquitos with the help of the female anopheles, the plasmodium parasites enters the bloodstream to reproduce. I also learned the differences of the symptoms of malaria and dengue fever. Dengue has longer duration of high fever than malaria. Dengue is more painful than malaria. Six years ago, I had dengue fever in the Philippines, after this case study, I learned that the dengue I had before is severe. Now I understood what my doctor told me before, he told me that I need to be careful next time because if I get infected again, it is going to be more dangerous...because... combinations of two different subtypes is very dangerous."* This student shows a knowledge of the science behind the disease but gets caught up in the comparison of malaria to dengue fever which was the student's experience. The global awareness comes as the event was in the Philippines, but it is muted by a focus on the student in the response.

An excerpt from a **Proficient** level response is: *"Malaria is a disease caused by a plasmodium*

parasite and is transmitted by the bite of an infected mosquito. Doing more extended research and finding out that at one time malaria was prevalent in Illinois, with the concentration in the southern part, was kind of scary. Malaria had 212 million estimated cases worldwide in 2015. The mortality percentage in global malaria has decreased by 62% between 2000 and 2011. Human efforts to control malaria have markedly restricted its distribution. About 1,700 cases of malaria are diagnosed in the United States each year. Malaria is transmitted in tropical and subtropical areas, where anopheles mosquitos can survive and multiply and malaria parasites can complete their growth cycle in the mosquitos.” This student seems to have a grasp on the science of

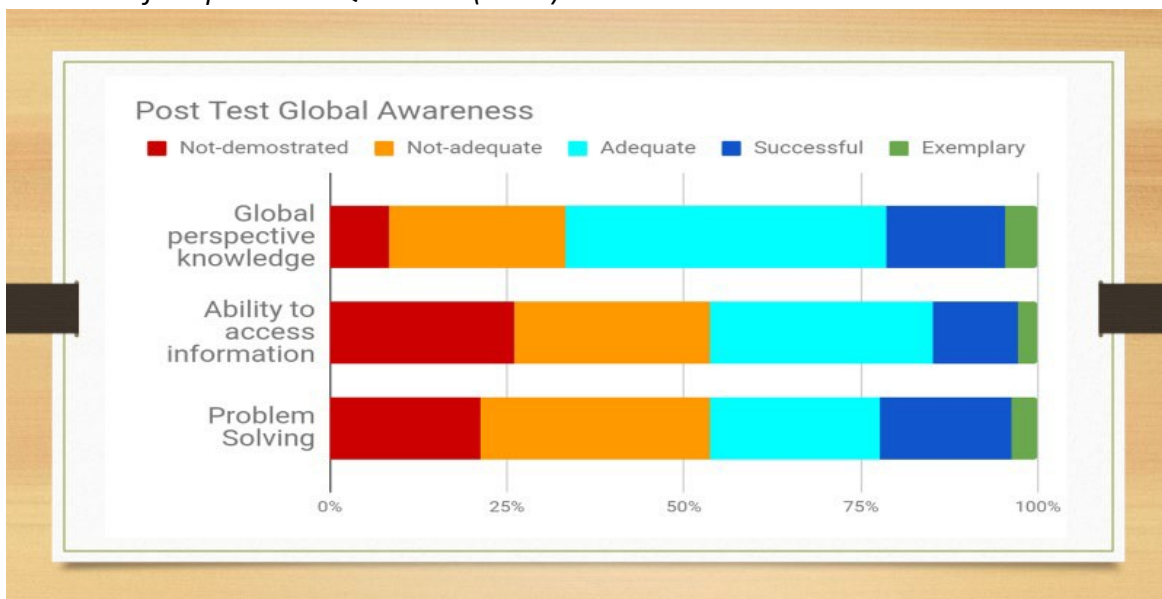
malaria, its global impact and the pathology of the disease, and while the student registers reaction to the information, there is a quick turn to the statistics and the world without reference to the self.

Post-Test (Assessing Global Awareness and Metacognition)

The same questions as the pre-test were administered to assess the gains on the outcomes also using our adapted rubric. Here you see students are registering across the spectrum of ratings on the three questions posed previously, and so gains were made on global awareness.

Table 3.

Post-Test Results of Responses to Questions (N=39)



Conclusions

There is still room for improvement as 18.7% of the group did not reach the adequate skill level on this unit. But, previously teaching the class without the case study, this instructor had seen 29.1% not achieving adequate skill levels. There is a general correlation between the assessment of the outcomes of the learning and global awareness as to how well the students did in the course. Because this unit carried 10% weight in

the overall grade for the class, it is difficult to extrapolate whether the students will remain as STEM students. However, we do have some insight that the changes in pedagogy made a difference from previous classes that did not include the case study.

Comparing two sections of microbiology from the Spring of 2018 which did not include the case study to two section from Spring of 2019, we saw a 10.4% increase in satisfactory

completion of the course. We reduced unsatisfactory completion of the course by 4.2% and we saw 22.8% fewer withdrawals.

Table 4.
Comparison of Microbiology Completion and Withdrawals Before and After Case Study Usage

Total N=48 each semester	Spring 2018 (w/o case study)		Spring 2019 (w/case study)		Differences
Satisfactory Completion: (A, B, C final grade)	N=34	70.8%	N=39	81.2%	+10.4%
Unsatisfactory Completion: (D, F final grade)	N= 6	12.5%	N= 4	8.3%	-4.2%
Withdrawals during semester:	N= 8	16.6%	N= 5	10.4%	-22.8%

We learned about some of misconceptions or barriers that seem to play a role in student learning. Knowing where students were in their initial learning state about global awareness played a part in targeting questions in each investigation to strengthen their awareness of the content within specific cultural contexts. This assessment provided some formative aspects as it allowed the instructors to work on weaker areas of content acquisition and provided a road map for students as to what inquiries that would be the foci of the case study.

Additionally, using an engaging group strategy helped to define student roles which increased efficiency for completing each task and taught the division and collective fruits of labor. Global awareness was demonstrated as groups provided different aspects on the case study in terms of interpretation, collation, and presentation of content. Finally, the reflections helped hone students' metacognitive and critical

thinking skills as they articulated their gains in learning how cultural contexts can determine outcomes in mitigations of disease.

We are already thinking about additional strategies and materials to be included in future uses. Presently, we shifted the case study to COVID-19 which has the added benefit of shared experience as well as the global aspects. We are asking ourselves if we can fine-tune the questionnaire for the pre-test and post-tests and whether we need to be more guided in the reflection thus finding a balance between open ended and directed responses. The practice of backward design in starting with the outcomes and retrofitting the assignments became invaluable to deliberately achieve the focus of global awareness, metacognition, and problem solving, so we are wondering whether the artifacts would be more effective in directing student response without imposing correct/incorrect answers. The time it takes to

code answers is impractical in a five-course teaching load each semester, so striking a balance here is important to convince colleagues of its efficacy and benefits.

The assessment techniques of the adapted incremental investigations we used helped us to improve student understanding and helped us to understand further student gains on the

outcomes. Choosing to include open-ended responses in the pre/post tests and the personal reflection allowed us to monitor student's gains in global awareness, metacognition, and problem solving. Our group work methodology should assist the students to apply similar strategies like creative inquiry and problem solving to improve competencies and engagement in interdisciplinary subjects.

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