ISB 202 has three main objectives for students: 1) Improving critical thinking skills, 2) Increasing science literacy and 3) Raising understanding of science as a way of knowing and not just a collection of facts. Over the course of seven weeks students engage with modules on psychology, physics, geology, chemistry, and biology. Although this may seem like an incredibly broad array of topics, lessons focused on concepts of energy and matter in each of the disciplines, except in psychology, which served as the introduction to critical thinking. Student
performance was based on pre/post tests, participation in discussion forums, and the development of thought in personal blog posts. The entire course is taught online and was taught simultaneously as a Massive Open Online Course (MOOC). This was one of MSU’s first explorations into the new MOOC educational model. As an educator, I believe it is important to focus not only on the quality of teaching and learning when trying something new, but also on the quality of the attempt to try new things. This MOOC pushed the envelope in not only teaching methodologies and collaboration, but in how we viewed learning, and the discourse that surrounds it.

II. Learning and Interaction Goals of the Course or Technology-enhanced Innovation
(what learning and interaction outcomes did you hope to achieve in your use of technology, why is this an award-worthy course or technology-enhanced learning innovation)

Collaborative curriculum design and open research experience:

The course was originally conceived to translate a face-to-face course co-created by Matt Rowe that has shown significant increases in critical thinking of students. We applied and received funding from the Bill and Melinda Gates Foundation and Desire2Learn to create an online course that could serve as a massive open online course in general science. Because this is a relatively new educational model, we invited the wider MSU community to participate in discussing MOOCs, using the development of this course as a useful context. We had approximately fifty faculty members take part in a hybrid Faculty Learning Community & wiki that was supported by F&OD and the Vice President for Research’s Office. The original grant from the Gates Foundation including funding for eight mini-fellowships as training opportunities for graduate students to get experience with MOOCs. We received forty applications from across the University for these eight positions. The quality was such that we sought additional funds to support additional graduate mini-fellowships. We received funds from the Associate Provost’s office, the College of Natural Science, the Office of Inclusion, and the Graduate School. We ended up with 23 graduate students participating in the creation of the MOOC. Students and participating faculty were broken into curriculum teams: physics, psychology, geology, chemistry, biology, podcasts, accessibility/diversity, educational technology, critical thinking, and assessment. The teams learned about pedagogical approaches like backward design and used these philosophies to create objectives, assessment questions, scripts, videos, podcasts.

Additionally we partnered with three other groups (MSU Librarians, CAL & LearnDAT) on campus to produce additional resources. The MSU Librarians produced a videocast series that looked at how to evaluate sources of information. The College of Arts and Letters Technology Office adapted one of their tools (the List Tool) for use in large-scale courses. We worked with LearnDAT to explore options, issues, and implementation of a badging system.

The work for the MOOC has already led to one publication and two more in preparation. The first publication deals with this aspect of group construction of curriculum:

• McCallum, C., Thomas, S., & Libarkin, J. (2013). The alphamooc: Building a massive open online course one graduate student at a time. eLearning Papers, 33, 1-9

The products developed in collaboration with the CAL Technology Office led to a grant submission and a poster presentation:


Incorporation of ideas from multiple disciplines:
One of the most rewarding aspects of the course was getting to work collaboratively with graduate students and university groups from different disciplines across campus. The combination of graduate students led to multiple positive outcomes including

• ESL techniques to teach scientific jargon
  o One of the graduate students had a background in teaching English as a Second Language (ESL). We were able to translate activities traditionally used for foreign languages into activities to mediate difficulties with scientific jargon.

• Multiple views of diversity and accessibility informed material creation
  o Faculty from Anthropology and graduate students from the HALE and MAET programs on campus provided feedback about images and activities that we developed to be sure that we were representing a diversity of opinions and that our images and activities were inclusive. For instance our introductory video contained images of scientists that transformed from a stereotypical older, white, male to a variety of ethnicities, genders, and abilities.

• Philosophical approaches to critical thinking
  o The main impetus for creating the course was to create an online intervention that improved critical thinking of students comparable to the face-to-face version co-created by Matt Rowe. We had two graduate students from the philosophy department who approached critical thinking from a different perspective than natural scientists, and a group of MSU librarians who approached critical thinking from an information literacy approach. They helped to create a more robust approach for teaching critical thinking. The curriculum included digital presentations covering topics of epistemology and blogging exercises that walked students through the process of asking their own questions, forming hypotheses, examining evidence, and evaluating between competing hypotheses.

• Citizen science experiences
  o One of our graduate students was very passionate about citizen science and connected the course’s learning objectives to online science experiments where students could participate and collect data. She developed a set of podcasts that connected module content to these citizen science projects. Students could play games that helped scientists solve protein folding problems, count populations of sea creatures, or quantify star maps.

Massive Open Online Course:
The course was run concurrently as a traditional online course at MSU and a massive open online course available to the general public. Eighty students were enrolled for credit through the University under the course code ISB 202: Applications of Organismal and Environmental Science. Approximately 1,250 learners enrolled from 37 states in the U.S. and 37 countries globally. We saw a similar attrition rate (~95%) that other MOOCs have reported. However, our educational model was designed to be more similar to a museum than a classroom. We approached the course as an informal science experience, where completion of the course was not an indication of course success. Similar to an exhibit in a museum, viewers who go in and...
view only a single exhibit do not indicate that the entire museum has failed. Instead we recognize that learners come in for various reasons (e.g. to learn more about a specific topic, to see what MOOCs are like, etc.) that can be distinct from course completion. This was one of many lessons that we learned about teaching MOOCs. Other lessons included the differences in learning barriers between for credit and non-credit students. For instance, pre-quizzes were a barrier for non-credit students because they made them feel bad; whereas, posttests were of interest to non-credit students because they wanted an indication of what they had learned. In for-credit students these trends were reversed. In addition to these topics we wrestled with issues of copyright, FERPA, educational technologies, accessibility, and hosting. These lessons have been communicated to the MSU community through multiple campus seminars:


III. Points of Interest and Innovation

(Please discuss course highlights and including URLs and/or screen shots of key components of the course or technology-enhanced learning innovation you want to bring to the attention of the judges. Possible outstanding aspects of the course might include student interaction, rich media content elements, interactive learning objects, assessment, effective incorporation of polling and surveys, facilitated teamwork, peer review, portfolio creation, etc.)

Collaborative creation of curriculum: Faculty and graduate students met in small and large groups to create curriculum and to brainstorm solutions to issues.
Social Media: In addition to Desire2Learn, social media applications such as Twitter and Facebook were used as vehicles for pushing content in the news to students.

Computer-generated animations: Each week, students were shown animated overviews of modules to show the connections between the various module content. New software, Videoscribe (http://www.sparkol.com?aid=32693) allowed animations to be created by simply dropping images onto a stage. A pre-recorded hand would then draw the images in the order they were placed. The image on the right shows the revised approach to be more cognizant of diversity in course materials.
Voiced over and interactive Powerpoints: These lessons served as one method for communicating content. Scripts were created to improve voice recordings and were later used for closed captioning and to make available for student download.

Digital badges: We worked with LearnDAT to offer digital badges for non-credit students as a means for increasing student motivation. LearnDAT was able to modify open-source code to enable this feature in D2L.

Scientists in the Wild: In this exercise, we showed students scientists working in the various fields and discussed how they got into the field and some of their thoughts on science.
Rubrics: All assignments were accompanied with rubrics that told students how they would be evaluated. For each module there were metacognitive exercises that helped students to “see like a scientist” (interpret data-visuals), “speak like a scientist” (interpret scientific jargon,” “act like a scientist” (participate in citizen science), and “think like a scientist” (apply critical thinking techniques).

<table>
<thead>
<tr>
<th>Level</th>
<th>See Like A Scientist</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (0)</td>
<td>Missing</td>
</tr>
<tr>
<td>Emerging (1)</td>
<td>Characteristics of pie chart are mentioned without connection to whether or not chart is a good example. Discussion of improvements is superficial or missing. Minimal reflection on how well chart conveys information.</td>
</tr>
<tr>
<td>Developing (2)</td>
<td>Characteristics of pie chart are connected to whether or not chart is a good example of information display. Discussion of improvements focuses on aspects that will improve information conveyance, including concerns about chart as presented.</td>
</tr>
<tr>
<td>Proficient (3)</td>
<td>Each characteristic of the pie chart is considered and related to aspects of information display, with judgments about how each characteristic relates to communication. Discussion of improvements and concerns relates back to pie chart characteristics, with suggestions for improvement and clear rationales.</td>
</tr>
</tbody>
</table>
Critical thinking exercises: In addition to voiced-over Powerpoints, the MSU Librarians produced video tutorials on evaluating information sources that students used to help them discuss current issues. We saw the biggest increase in critical thinking in those who came in with low prior critical thinking skills.
ListTool: This tool developed by the College of Arts and Letters Technology Office allows students to submit materials and have their peers vote the material as good or bad. Those materials that are rated as “good” migrate higher in the list. The tool was redesigned to accommodate the large enrollment of the MOOC. We are currently working with the CAL Technology Office to see how tools developed for MOOCs can help large face-to-face classrooms and vice versa.
Citizen Science: Each module, students were given the chance to participate in scientific studies in the topic area for that week. This had students looking for scallops at the bottom of the ocean, stars in the vastness of space, or potential configurations for disease proteins; they did not have to imagine themselves as scientists because they were taking part in actual science experiments!
IV. Accessibility

(It is not a requirement that winning entries be accessible to learners with visual, auditory, mobility, and cognitive disabilities. However, if your course content or technology-enhanced learning innovation is accessible, or if it incorporates an innovative approach to accessibility, please describe.)

As mentioned earlier, we had a Diversity and Accessibility Team who looked at our materials and content with an eye for how we could reach broader audiences. Some of the strategies that we employed:

- All voice recordings (lectures, podcasts, videocasts, etc.) were recorded from scripts. PDFs of the scripts were made available for students.
- For YouTube clips we originally had their free closed captioning enabled, but when that proved too unreliable, we had closed captioning done.
- We had a deaf student in the MOOC request closed captioning for the lectures, so those scripts were synced and embedded with the lectures as closed captioning.
- We created two versions of the lecture one that was more interactive and one that played on more types of devices.

V. Evidence of Effectiveness with Students

(Please include evidence such as comparative test scores, SIRs results, short student letters of support, your own observations of project or group performance, etc.)

There were four measures of that when taken in combination provide evidence of effectiveness with students: SIRS, CISGS Deep Thinking Scores, and Pre/Post Critical Thinking Scores.

SIRS: University courses are required to administer Student Instructional Rating System (SIRS) surveys for students to provide feedback of their classroom experience. SIRS scores for ISB 202, where 1.00 is best possible score.

<table>
<thead>
<tr>
<th>Score Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest score on, “Course has increased my interest in science.”</td>
<td>2.08</td>
</tr>
<tr>
<td>Highest score on, “Instructor encouraged student engagement.”</td>
<td>1.48</td>
</tr>
</tbody>
</table>

Sample positive comments:

- Great instructor learned a lot and have never had a class like this. I really enjoyed having the opportunity to give my own opinion and also make replies to other students.
- I came into this class with pretty low expectations - I have taken numerous science classes in the past and I did not think I would learn anything. However, Professor Thomas exceeded any expectations with the creative setup of this class. ... I was able to think about things I have already learned in new ways (for instance, comparing plate tectonics to Atlantis) and the class was very enjoyable, especially for an online course.
- It was a lot of fun. I greatly enjoyed the course
- LOVED THIS CLASS!!

CISGS Programmatic Evaluation: In addition to the SIRS survey, the Center for Integrative Studies in General Science (CISGS) administers additional survey questions for programmatic assessment.
Survey questions that probed student perceptions of course and instructor scored 2.29 on a range of 0-3 (with 3 being the most positive). The average for courses in the CISGS averaged 2.16 in the previous year.

Additionally, multiple questions look at the types of experiences and activities students engage in the class that might support “deep learning approaches.” Again with a scale of 0-3 with 3 being the most deep learning approach, the course scored 1.80 and the average for all CISGS courses was 1.12. No class scored higher than this online course. Only face-to-face laboratory courses have scored this high on this scale.

**Critical Thinking Assessment:** Because one of the main objectives of the course is critical thinking, we developed a valid and reliable scale for measuring improvements in critical thinking and acceptance of science and pseudoscience. For-credit students were assessed pre/post, we found that

- Students improved in critical thinking skills \( t(83)=3.97, p<0.001 \)
- Students’ belief in pseudo science decreased \( t(83)=3.47, p<0.001 \)

**Quality Matters Evaluation:** “Quality Matters (QM) is a leader in quality assurance for online education and has received national recognition for its peer-based approach to continuous improvement in online education and student learning.” - [https://www.qualitymatters.org/](https://www.qualitymatters.org/)

Our ISB 202 course has passed their newest evaluations developed specifically for MOOCs and can now be listed as a Quality Matters course.

Taken in combination we were pleased that the course was rated highly by students, exceeded expectations of our program, reached our main learning objective for the course, and passed external evaluation.

**VI. Plans for Sustainability**

*(Describe future plans for your course or technology-enhanced learning innovation.)*

**Community generated curriculum:**

Part of the philosophy behind the collaboratively designed curriculum is that all participants equally own all of the materials. As such, the materials can be used and modified by all participants. Even more, it was decided early on that all materials would enter Creative Commons and be available for anyone to use and/or modify. One benefit of having a community generate and use the materials is that they can be improved upon and passed into other contexts. Already the course content has been adopted by another course and instructor; the materials have been modified and improved upon.

Having groups gain experience creating different facets of the curriculum helped to train them in production of online materials, objectives, and assessments, so they might be better able to produce or adapt these materials in the future. One of the difficulties when working with a team in creating online content, is if you did not create the material, when you have to modify it at a later date, you often have to find another expert to help you. Hopefully by having members of the group help create content, they are more apt to modify those resources in the future.