HOW DOES DEVELOPING AN ONLINE FIELD ECOLOGY COURSE TO SUPPORT HIGH SCHOOL STUDENTS IMPACT MY GROWTH AS A TEACHER?

by

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A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2017

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ABSTRACT

The purpose of this project was to investigate how developing an online field ecology course for high school students impacted my growth as a teacher. I teach at an independent high school (N=410) in the San Francisco Bay Area. Three years ago my school joined a BlendEd online consortium. I was asked to teach an online field ecology course for the program. I had no experience with virtual learning as a teacher or student at the time. Data collection for this project not only included teacher journaling and reflection, but also course and teacher surveys from my online and traditional classes, a catalogue of teaching practices, and a trans-classroom teacher survey to compare my experience and growth with other trans-teachers. (Trans-classroom teachers are teachers who teach in both online and traditional classrooms.) The results indicate that I have made changes to teaching practices since teaching online. For example, results of my gall lessons with my online and traditional groups illuminate how online teaching has inspired me to employ multiple new practices like the use of homework kits and science notebooks in my traditional classes. Additionally, developing an online ecology course required me to participate in a wide range of professional development opportunities that all of my students were able to benefit from. Finally, the results of my trans-classroom teacher survey confirm that my experiences are not unlike other trans-teachers; 88% of teachers that I surveyed indicate that their traditional teaching was somewhat or very impacted by their online teaching. After 17 years traditional teaching, I have found online teaching to be invigorating and an opportunity for reinvention.

INTRODUCTION AND BACKGROUND

School Demographics

Marin Academy High School, is located in San Rafael, California, the North Bay region of the San Francisco Bay Area. The Bay Area is home to Silicon Valley, Stanford, and Berkeley. The region has the second highest density of Fortune 500 companies in the US. NASA Ames Research Center, Google, Genetech, LinkedIn, Twitter and Saleforce are a few of the companies currently based in the Bay Area. Despite the region's high cost of living, the Bay Area's innovative economy, high productivity levels, and spectacular biodiversity continue to make the area an attractive place to live and work. The 2015 median household income in San Francisco was $30,000 more than the rest of the US (compare $88,518 to $55,775).

Marin Academy is a small, independent high school of 410 students. lt is located in the North Bay, specifically Marin County, of the San Francisco Bay Area. Marin Academy's students largely come from Marin, San Francisco, the East Bay, and Sonoma. Tuition at Marin Academy for the 2016-2017 year is $42,100, while, 26% of the school's student body self-identify as non-white.

Marin Academy is part of the Bay Area's BlendEd Consortium, which is a new take on education; the consortium mixes traditional face-to-face classroom teaching and experiential learning with online instruction. Five independent schools in the Bay Area make up BlendEd: The Athenian School, The College Preparatory School, Lick Wilmerding High School, The Urban School and Marin Academy. The five schools jointly offer a set of BlendEd classes. Students from any of the five schools may take

BlendEd courses offered by the consortium. Ten classes currently make up the BlendEd electives, including: Bay Area Field Ecology, Climate Change, Creative Writing: Very Short Stories, Mandarin V, Bay Area Cinema, Beat, Rhymes & Life, #Entrepreneurship and Environmental Justice and the Social Determinants of Health. Many of these courses try to leverage local area resources and fulfill a niche that a home school may not offer.

Teaching Context

As shown in Appendix A, I have had a rich teaching career for 17 years prior to teaching online. My primary teaching assignments as a traditional face-to-face teacher were delivering Biology and AP Environmental Science content. I started teaching an online course three years ago.

This Action Research (AR) took place over the last three years during which time I was taking online courses at MSU, developing and teaching an online course for the Bay Area BlendEd Consortium, and teaching traditional courses at Marin Academy.

Background

When I was asked to teach an online class for the Bay Area BlendEd Consortium, I had no experience with online learning, and was eager to figure out what online learning was all about. Montana State University (MSU) stood out because the Masters of Science in Science Education (MSSE) program had online field courses such as Streamside Ecology.

Over the last three years there has been little interest from my colleagues about the consortium. I have been the only teacher from Marin Academy teaching an online class. Many fear that online teaching diminishes the relationships they establish in the

traditional classroom, specifically, in relation to in-person content building and design. Marin Academy's long-term vision is to build a large group of teachers who actively build curriculums in BlendEd. While I can relate to many of my colleagues' concerns, my experience has been markedly different than I first imagined it would be.

I was asked to take over as Coordinator for our school's BlendEd program in the Spring of 2016. This new role requires me to represent the benefits of online learning for our school community. Among my tasks, I have been asked to recruit more students to enroll in online classes and more educators to design and teach these online courses.

Teachers who teach in both online and traditional classrooms are called trans-classroom teachers, because they move between environments (Lowes, 2008).

Focus Question

My primary research question for this project was: how does developing an online field ecology course for high school students impact my growth as a teacher? My secondary questions were: (1) What changes to my teaching practices can I describe and illustrate as a result of my transition to online teaching? (2) How does online teaching impact my traditional teaching? (3) How does my own growth as a trans-classroom teacher compare to other trans-classroom teachers?

CONCEPTUAL FRAMEWORK

Virtual learning is being embraced more regularly as it becomes increasingly common and accepted. In the United States higher education, 25% of all college students are enrolled in at least one online course (Shea & Bidjerano, 2010). Additionally, according to *i*NACOL's (North American Council for Online Learning) 2015 report more

than 40% of high school and middle school students have expressed interest in taking an online course (Dobrovolny, 2015). In 2006 Michigan became the first state to require virtual learning before high school graduation (DiPetrio, Ferdig, Black & Preston, 2008). Not only are online learning opportunities increasing rapidly, but research is showing that online education has transcended the "no significant difference" phenomena (Shea & Bidjerano, 2010). When course materials and teaching methodology are held constant, there is no significant difference; online and traditional face-to-face classrooms have proven to provide equivalent experiences in the most exemplary cases. The purpose of my action research project was to investigate how developing an online BlendEd high school field ecology has supported my growth as a teacher

Migration path for high school trans-teachers

Susan Lowes's study was based on the full migration path for 215 virtual high school teachers (2008). These trans-classroom teachers moved between face-to-face and online education. Her study outlined how teachers transferred ideas, strategies and practices from one teaching environment to the other. Nearly all of the educators teach face-to-face and an online course. Studying the pedagogy of online teaching is a requirement for these educators. They must engage in a rigorous professional development course. They cannot simply transfer their methods and lessons from a live course to an online course. Instead, these virtual educators enter into an intensive reflection based on their professional development experience. The end result is an online course that looks very different from the traditional course.

The 215 teachers that participated in Lowes' study were asked to answer six open-ended questions about the challenges and impact of online teaching. Seventy-five percent of the educators surveyed in Lowes' study transformed their face-to-face classroom teaching in both pedagogy and content areas after teaching online courses. The most frequent change reported was that 69% of participants ended up redesigning their traditional courses. This was after reflecting on their design and activities that could be reengineered to optimize valuable face-to-face teaching time. Moreover, these same teachers ended up adding more instructions to their traditional classrooms based on what they had learned through their online communication.

A challenge that surfaced in Lowes' study was the idea that many teachers suggested that creating an entire course in advance was taxing because of the loss of flexibility to dig deeper or slow down depending on student's comprehension.

Professional Development

Professional development has shifted greatly over the years. Historically teacher training consisted of exposing teachers to a concept in a one-time workshop or giving teachers basic knowledge about a teaching methodology. However, time and research have demonstrated that the programs that have the greatest capacity to add to teacher education and the greatest likelihood of influencing teaching practice are those done "by" and "with" teachers. Teachers are not consumers of external knowledge but coproducers and agents of change in the problems that really concern them in their classes. This is what action research programs are. Bartolome Vazquez-Bernal et al, describe a

longitudinal project with a secondary education science teacher. This project detailed an individual teacher's action research reflection and study and how this influenced her professional development (2011). The authors describe how action research studies can be powerful because this type of professional development for teachers can be presented as an internal process of growth. Teachers engaged in action research are approaching real problems they face in their own classes and within a context that they work.

Candace Jaruszewicz elaborates on these ideas describing how when teachers share ownership of their own growth, the energy produced by intellectual dialogue about their goals and aspirations infuse their work (2009). Accordingly, individualized professional development plans, like action research projects, are worth the effort they take to create.

Bill Boyle's longitudinal study on teacher change looked at three popular professional development activities; observation of colleagues, sharing practices and on-site/on-line courses (2004). Seventy-seven percent of the 779 participants in Boyle's longitudinal study who engaged in one of these professional development activities changed at least one aspect of their teaching practice. In Boyle's study, just over 51% of respondents indicated that they had made changes in their planning, 43% made changes to their teaching style and 40% of respondents made changes to their assessment practices. A notable comment from one of the participant's in Boyle's study related to aspects of teaching practice change was, "This professional development enabled me to reflect on my practice and generate lots of new ideas to extend to pupils."

Teacher Reflection

Beatrice‘s study discusses factors that influence professional development and the effectiveness of professional development (2011). Avalos defines professional development as, “teachers learning, learning how to learn and transforming their knowledge into practice for the benefit of their students’ growth” (Avalos, 2011, p. 1). The study reviewed 111 teacher professional development journal articles. Avalos describes the relevance and importance of teacher reflection in professional development (2011). Many of the studies described teacher reflection as an instrument for change. For example, one study discussed the contribution to reflection of narrative methods such as storytelling and the construction of stories within professional development activities. These narrative accounts reveal how emotions impact professional development. Activities like narrative and storytelling enhance cognitions and reflection and ultimately lead to new or improved teaching practices.

O’ Sullivan, Ross and Bruce’s research related to how teachers’ learning relates to professional development (2007). This article described how teachers learn, what they bring to their learning efforts and how these efforts are reflected in changes in cognition, beliefs and practices. One of the key take-aways from this paper was the model of teacher change that was centered on teacher self-assessment. The illustrated model featured three steps for teachers. Step one was a self-observation of aspects of teaching relevant to success. The second step was teachers setting goals and reflecting on the purpose of the proposed teaching goals. The final step requires teachers to reflect or interpret the extent to which goals have been attained and the degree of satisfaction with

the process. This process ultimately affects future decisions about teaching. The model also includes how peers can provide feedback to the entire process. Colleagues or peers could potentially add feedback that supports or competes with the teacher's self-assessment. This type of external feedback can help in the process of professional development.

This self-assessment model provides a strong framework for goal setting, reflection and peer feedback for professional development.

Science Notebooks

Maria Araceli Ruiz-Primo and Min Li's research on using students' science notebooks as assessment tools, relates to professional development and specific structures related to teaching practices and change (2004). This article addresses how students' science notebooks are used as a method for examining both student performance and some aspects of opportunity to learn. The authors considered three aspects of opportunity to learn that can be measured using students' notebooks as a source of information: unit implementation, quality of notebook entries and teacher feedback to student performance. The authors suggest that studying science notebooks reveal what teachers focus on in the science class. Science notebooks serve as way to monitor student learning and the classroom-learning environment. By observing what students write or do not write in these notebooks, a keen teacher can infer the tone of the classroom.

Moreover, the Ruiz-Primo and Li article discusses the importance of scientific practices that can be implemented and incorporated into science notebooks; like documenting accurate and systematic procedures, concepts and models. Their research

indicates that students' learning and understanding is improved if students are asked to write in science journals in purposeful ways.

Online schools "Doing school"

The Stanford Online High School (SOHS) is an independent school that offers courses for grades 7 to 12 (Scarborough and Ravaglia, 2014). The school was founded in 2006 with a gift from the Malone Family Foundation as a three-year high school. The school is made up of full time students (5 classes), part time students and students taking 1 single class. The school is accredited by the Western Association of Schools and Colleges and offers diplomas to students who meet its academic requirements. In 2015, SOHS had a graduating class with 49 seniors. Teachers are largely-full time employees of Stanford University. Many of the teachers at SOHS never planned to teach at an online high school. The majority of the SOHS teachers have university level backgrounds, are passionate about their subject areas and love working with smart students.

SOHS is like many small schools in that it emphasizes small discussion based classes, puts great emphasis on student-teacher interaction and offers a deep curriculum along with academic and college-counseling support.

Scarborough and Ravaglia emphasize that when approaching online learning, a teacher must get the learning environment right; "it is the 'schoolness' that is essential and not the 'onlineness'" (Scarborough, 2014, p. 416).

An additional theme that emerges in Scarborough's work is the difference between content and learning. Scarborough and Ravaglia point out that when phrases

like content management system and learning management systems are used interchangeably it underscores the perception that content and learning are the same thing. However, they remind the reader that content knowledge is only a small piece of what we expect our students to take from education, “it has long been a favorite line about education than ‘an education is what remains when we have forgotten everything we have learned “ (Scarborough, 2014, p 438). Scarborough and Ravaglia detail strategies that SOHS use to teach students how to think and how to learn and not just how to memorize facts.

METHODOLOGY

Data Collection Methods

To answer my primary research question: how has developing an online field ecology course impacted my growth as a teacher, I collected data via surveys, a catalogue of teaching practices, pretest and posttest scores, colleague observation, colleague free responses, a teacher journal and a trans-teacher survey (Table 1). To ensure research was both valid and reliable, I used at least three methods to triangulate data for each research question.

Table 1
Data Triangulation Matrix

Research Questions	Course and Teacher Surveys	Catalogue of teaching practices	Pretests and Postests	Observation Instrument	Colleague free response	Teacher Journal	Trans-teacher Survey	Member Checking Survey
What changes to my teaching practice can I describe and illustrate as a result of my transition to online teaching?	X	X				X		
How does online teaching impact my traditional teaching?	X		X	X	X	X		
How does my growth as a trans-teacher compare to other trans-teachers?						X	X	X

Comparison

In this study there were two classes that were compared to see how online teaching has affected traditional teaching. My advanced biology (traditional) class has daily face-to-face interactions and opportunities to layer content in person and through regular homework assignments. My field ecology (online) class has face-to-face interactions three to four times a semester for field-based lessons. Students develop content knowledge through online media and resources while completing the majority of assignments online. Students in the online ecology course spend more time outside

exploring, observing and studying ecology than any of the traditional courses. The field work in online ecology covers data collection, field journaling techniques, binocular and macro lens work and natural history interpretation.

Participants

Enrollment for all of these courses is small as shown in Table 2. The online class, is juniors and seniors from the BlendEd Consortium. The traditional class, includes students from Marin Academy only; juniors and seniors.

Table 2
Enrollment for Advanced Biology and Field Ecology Courses Over a Three-Year Academic Cycle

	Advanced Biology Traditional	Field ecology Online
2014-2015	19	9
2015-2016	26	5
2016-2017	17	9

My professional teaching and learning experiences in science and teaching are represented in Appendix B. I have taught life science throughout my entire career with the most experience teaching biology for 18 years. My most recent teaching experiences have been online ecology (3 years) and a 10th grade exploring experimental design semester course (1 semester).

Data Collection Methods

Changes to teaching practices

To catalogue changes to my teaching practices I reviewed and studied course syllabi from advanced biology and online ecology. Aspects of different teaching practices like formative assessments, summative assessments, homework practices, use of technology, communication, individualized learning, frequency of assessing work, responsive teaching and research opportunities were identified and described and added to a table cataloguing teacher change.

Technology that was described and categorized in the table included Peardeck, discussion boards, citizen science apps, Google Earth, and virtual labs. Peardeck is an interactive slideshow that allows students to join the presentation and respond to prompts anonymously. Discussion boards are online tools which allows students to communicate asynchronously and on their own time. Citizen science is the collection and analysis of data typically relating to the natural world by the general public and usually part of projects alongside professional scientists. What's invasive, inaturalist and NoiseTube are examples of apps that facilitate citizen science data collection. Google Earth is a geographic browser that allows individuals to share data. Virtual labs allow students to explore scientific concepts in an inquiry fashion in a risk-free environment online.

Each practice was reviewed to determine if this was an additional practice or if this practice replaced a former teaching practice. Changes to teaching practices in traditional and online courses were also based on when each practice was introduced to courses between 2014 and 2016.

The incorporation of science notebooks was used to demonstrate changes to teaching practices. Science notebooks were first used in the online class as field notebooks to document observations, sketches, questions and research. Science notebooks were then added to traditional classes to document experiments, record questions about content and understanding. The use of science notebooks helped changed formative assessment practices, increased individualized learning and research opportunities in traditional classes. Students in these classes used their notebooks to design and collect data for two longitudinal Fast Plant Studies; one first semester and one second semester. Students had the opportunity to reflect on their use of these journals to make changes to the way they collected data and designed their beta Fast Plant studies.

Students in both online and traditional classes were surveyed regarding their experience using science notebooks. The survey questions were:

- *Please rank your experience with using a science journal in this course.*
    - *Excellent*
    - *Above Average*
    - *Average*
    - *Below Average*
    - *Very poor*
- *Please comment on your experience with using a science journal in this course.*

Survey results illustrating student experience were used in conjunction with sample notebook entries in order to determine trends. Student data was then paired with teacher reflections (teacher journal) to help answer my research question.

Course and teacher surveys from my online classes were used to support data on teaching practices. Likert scale surveys related to course structure and teaching practices were administered to online classes at the end of spring 2015 and 2016. Students

completed an anonymous survey related to course structure and teaching practices at the end of the semester course. In the fall of 2016 students completed an anonymous survey mid-semester. A copy of the survey is included in Appendix C. The questions were developed for students enrolled in all online courses by the director and site coordinators of the Bay Area BlendEd consortium. The Likert scale survey had 12 questions related to course structure and teaching practices. For each question on the survey, student responses were quantified with 1- being not at all true and 5- being very true. There were also opportunities for students to explain their answers through open-ended response questions.

Survey questions were split into two categories; (1) teaching practices: and (2) course structure. Within each category, emerging themes were identified and data from all three years was compared.

Course and teacher surveys from my traditional classes were also used to support data on teaching practices (Appendix D). Likert scale surveys related to course structure and teaching practices were administered to traditional classes at the end of spring 2016 and at the end of the first semester of fall 2016. All of the teacher practice questions and three of the course structure questions were identical to the online survey (Appendix C and D). There were opportunities for students to explain their answers through open-ended response questions. Additionally, students answered five open-ended questions related to the course and teacher.

Professional development that I participated in was used to substantiate survey questions addressing teacher knowledge of the subject area. Examples of changes to

teaching practices and answers to open-ended questions were compiled together to help support and validate trends from the Likert teacher surveys.

A tally of how often students evaluated the teacher, course or an activity was kept to illustrate changes in teacher practice and show how the frequency of surveys changed over time. This data was paired with qualitative data from course and teacher surveys regarding teacher responsiveness and teacher journal entries (Appendix E) to illustrate how the use of surveys played a direct role in teacher reflection, course refinement and changes to teaching practices.

How online teaching impacts traditional teaching

In order to understand how my online teaching impacts my traditional teaching, a gall ecology lesson was used as a case study. The gall ecology lesson is a useful case study to show applications of teacher change in my traditional classroom because many changes to aspects of my teaching practices are featured in this lesson.

The same gall ecology lesson was taught to the online and traditional classes (Appendix F). The timeline is in Table 3.

Galls were selected as the topic of study because this subject matter relates well to both online and traditional classes. Galls are accessible and common and frequently found on California oak trees. Plus, three oak trees on the Marin Academy campus harbor galls that students can easily observe.

Table 3
Treatment and Timeline for Gall Ecology Lesson

Activity	Tentative Dates
Gall Ecology Lesson	Fall Semester
Teacher reflection on thoughts going into lesson.	
Tally student scores on pretest and post tests posttests	
Lesson on Galls and in class (or online) gall observations (Lesson 1)	
Student Journal observation on Galls independently (Lesson 2)	
Department Head or colleague observes formative assessment (observation)	
Interview Department Head or colleague to debrief lesson observation.	
Survey students to debrief lessons.	
Teacher reflection on lesson, observation instrument feedback and results	

Students reviewed a Powerpoint on gall ecology and watched a teacher screencast video with the same content. Both classes engaged in a field journal observation where they had to observe galls that were gathered for them, outside of the classroom and journal about their observations.

After completing the lesson, the traditional class was given an in-class assessment which was observed and documented by a colleague. Students participated in a Peardeck review activity in class. There were multiple opportunities for students to explain concepts to a partner sitting next to them and there was one prompt that asked students to share their gall journal observations with the students at their table. A colleague observed this assessment and used a formal observation instrument (Appendix G) to document the assessment lesson.

I had planned to assess the online group in the same manner during our last face-to-face meeting; however time constraints altered the plans. Instead of incorporating the Peardeck activity students were paired up and asked to create a 2-4 minute interpretive talk on gall ecology as part of their certification test. Students had to prepare an outline and then they had to make a video of their interpretive talk. The goal was to record the talk only once and treat the assignment as if it were an interpretive talk in the field where presenters have one chance to deliver the message; video editing was prohibited. The same colleague who observed the traditional class reviewed the videos and provided open-ended feedback regarding these videos as assessments.

Pre and post test scores were used to assess student learning for both groups (Appendix H). Moreover, traditional students were asked to indicate which part of the gall ecology lesson was their favorite; gall kit, screencast video, Peardeck review, PPT on gall ecology, science notebook observations, or other. Results were used to identify how teaching practices in the traditional classroom changed and how students were experiencing these changes. To understand how online teaching practices impacted the teacher, a teacher journal was maintained throughout the unit.

Results of the pre and post test scores were determined by calculating average normalized gains for the online and traditional classes. Teacher journaling and student/colleague feedback and observations were used in conjunction with pre and post test scores to explore the impacts online teaching had on a traditional classroom.

Comparing Experiences

In order to compare my growth as a trans-classroom teacher to the growth and experience of other trans-classroom teachers (subquestion 3), a survey was distributed to trans-classroom teachers in the Bay Area BlendEd consortium and trans-teachers in two other online consortiums; Global Online Academy and Eight Schools Association (Table 4, Appendix I).

Table 4
Number of Trans-Teacher Survey Respondents

Online Consortium	Number of Trans-teachers	% of teachers participated in survey
Bay Area BlendEd Consortium	10	90%
Global Online Academy	15	87%
Eight Schools Association	10	20%

The timeline for the deployment of these surveys and interviews is in Table 5. Survey data was paired with teacher journal reflections, written before and after the survey (Appendix G). Pre survey reflection answered the questions," What am I interested in learning from the trans-survey? and, What types of actions and practices have I changed since teaching online?". Post survey reflection answered the questions, "What did I learn from the trans-survey? What specific things do I have in common with trans-teachers and what are some of the differences between trans-teacher experiences?" After the trans-survey, a few participants were asked to evaluate survey findings (Member Checking). Members were asked what questions or additional comments they had related to the data and my interpretations.

Table 5
Treatment Schedule for Trans-Teacher Survey and Member Check in (Sub Question 3)

Data Collection Method	Tentative Dates	Reasoning
Survey for Trans-teachers	December 2016- January 2017	This is the end and the beginning of the semester. I want to capture my colleagues' attention during a transition period. I hope that at the end of the teaching semester when grades are finished OR at the very start of second semester my colleagues can fit this in without feel rushed or overwhelmed.
Interviews for Trans-teachers	January 2017	I want to take advantage of the start of the second semester when the roll out of the semester's work is slower than mid-semester. I will do these after I have completed all of the surveys.
Teacher Reflection	December 2016 and January 2016	I plan to do a reflection before the survey and after the survey.

Emerging themes were identified and responses were categorized into; course organization, course design and redesign and communication. Open-ended questions and the member check in responses were discussed in the qualitative data analysis. This information was then triangulated with teacher journal reflections.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix J).

DATA AND ANALYSIS

In order to answer sub question 1, "what changes can I describe and illustrate as a result of my transition to online teaching?" changes to my teaching practices were recorded, catalogued and are presented in Tables 6 and 7.

Table 6
Catalogue of Changes in Aspects of Teaching Practice

Practice	Example	Where & How was it incorporated?	Added or Replaced content?
Formative Assessment	Science notebooks	Science notebooks were incorporated into all classes as a way to monitor students' ongoing progress, provide immediate feedback and to help students build a record of their work and progress. In the 2016 and 2017 academic year notebooks were used in Advanced Biology for two longitudinal Fast Plant studies (alpha and beta).	Added
Summative Assessment	Lab Practicals	Advanced Biology; lab practicals were added at the end of unit to measure student's achievement and learning. Lab practicals replaced summative tests given in the past.	Replaced
	Certification test	In online ecology a field practical replaced a longitudinal final project.	Replaced
Homework practices	Kits	Kits were sent home with Advanced Biology students. Kits allowed students to do hands on activities like observing galls and comparing tree leaves at home.	Added
	Screencast videos	Screencast videos were used with traditional classes to build content at home before in class exercises, projects or labs.	Added
Use of Technology	Peardeck	Technology used in online class became agents of change in traditional classes; Peardeck helped make lectures in traditional classes more interactive and transformed some presentations from lectures to formative assessments.	Added
	Discussion boards	Discussion boards were used in Advanced Biology to facilitate open-ended discussions and allow students to investigate content and discuss it on their own space/time.	Added
	Citizen Science	Citizen science projects were incorporated regularly into traditional classes. Citizen Science increased the opportunities for students in all classes to collect, analyze and interpret data. Citizen Science also immersed all students in local environmental issues and experiences. Examples: inaturalist, What's invasive app, NoiseTube app	Added
	Google Earth	Google Earth was used initially in online classes to tour ecosystems around the planet. Added to traditional classes to augment content through evaluation of images and data.	Added
	Virtual Labs	Virtual labs (invasive species labs) were used initially in online classes and then added to traditional classes to review content and provide instant feedback.	Added
Communication	More detailed instructions for labs and projects	In all traditional classes directions have been simplified and replaced with more detailed instructions in order to add clarity.	Replaced

Practice	Example	Where & How was it incorporated?	Added or Replaced content?
Individualized learning	Science Notebooks	In Advanced Biology science notebooks were added to facilitate and monitor on going progress. Notebooks helped to address individual needs and goals. Notebooks helped to facilitate personalized learning goals for each student.	Added
Assess work more frequently	"Daily" homework and science notebook feedback	Online teaching helped me transfer technique of putting more time/frequency into formative assessment. This feedback was a means of helping students gain information about how and what they understand and misunderstand. This feedback also helped students find directions and/or offered strategies that students could use to improve.	Added
Responsive teaching	Increased surveying	In all classes the use of increased surveys were used to attend to and respond to students' thinking, questions, observations , experiences and feedback.	Added
Research opportunities	Science notebooks	Science notebooks in traditional classes allowed for more authentic inquiry labs and experimentation. Notebooks also served as a incubator for future research questions and ideas for students.	Added

Table 7

Changes To Teaching Practices in Traditional and Online Courses Between 2014 and 2016 (Advanced Biology (AB), Online Ecology Spring (OE S), Online Ecology Fall (OE F))

	2014	2015		2016		
	AB	AB	OE S	AB	OE S	OE F
Peardeck				X	X	X
Discussion boards			X	X	X	X
Science Notebooks			X	X	X	X
Homework (Kits & Screencast videos)			X	X	X	X
Citizen Science			X	X	X	X
Lab Practicals	X	X		X	X	X

Many aspects of my teaching practice have changed as a result of online teaching; formative and summative assessments, homework practices, the use of technology,

evaluation and survey frequency and research opportunities. Lab practicals and certification tests have replaced traditional tests, while practices such as science notebooks, homework kits, screencast videos and citizen science, were added as a result of teaching online (Table 6).

Many of these practices were piloted with the 2015 spring online ecology group (Table 7). Discussion boards and screencast videos were features of the online class from the very beginning (Spring 2015). The use of science notebooks and homework kits to measure and record data in the field for online ecology were novel teaching practices introduced during the first year of online ecology. These two practices were deliberately added to help provide students with opportunities to consistently practice science by collecting and recording data independently in the field. Citizen science projects and the use of apps like inaturalist and Noisetube, were implemented and introduced to traditional and online courses during the Spring of 2015 (Tables 6 and 7). The practice of adding research projects like inaturalist projects to traditional and online courses was a direct result of developing an online field ecology course for high school students. By the end of this action research project, all of the teaching practices described in Table 7; Peardeck, discussion boards, science notebooks, homework kits, screencast videos, citizen science and lab practicals, were added to traditional classes.

Survey data supporting changes to teaching practices described in Tables 6 and 7 is presented in the following section. Questions pertaining to teacher content, knowledge, preparation, resourcefulness, and ability to provide feedback are discussed (Appendix C and D).

Figure 1 is a compilation of three years of surveys to question #5 “My teacher provides prompt feedback” (Appendix C and D).

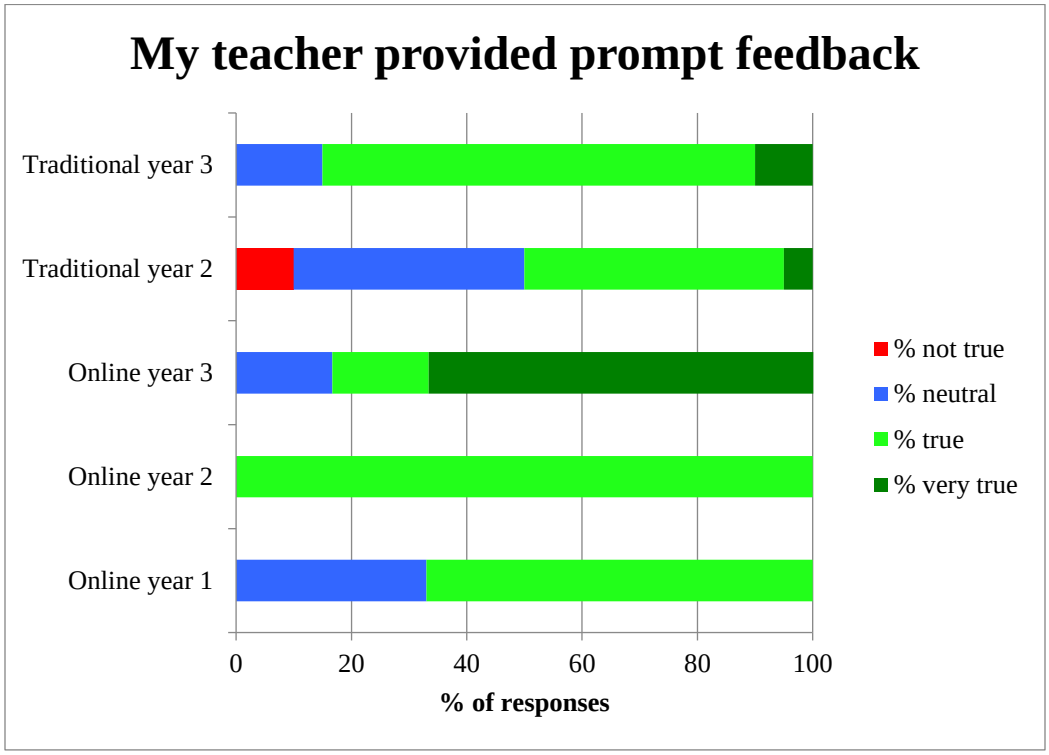


Figure 1. Survey responses to question #5, “My teacher provided prompt feedback” (Online year 1 *N*=9, Online year 2 *N*=4, Online year 3 *N*=6, Traditional year 2 *N*=26, Traditional year 3 *N*=17).

Student quotes correlate well to trends in Figure 1. An online student in year three summarized how prompt feedback impacted progress. “Liz’s feedback was specific and timely and definitely helped me improve my understanding of concepts. I think my journal entries improved over time.” Similarly, a traditional student in year two remarked positively about the impact of swift feedback. “Liz provides the fastest feedback of any teacher I have worked with. It seems like she wants us to immediately see our mistakes and think about them and try again.”

Figure 2 is a compilation of three years of survey responses to question #1, “My teacher has a strong knowledge of the subject area.”.

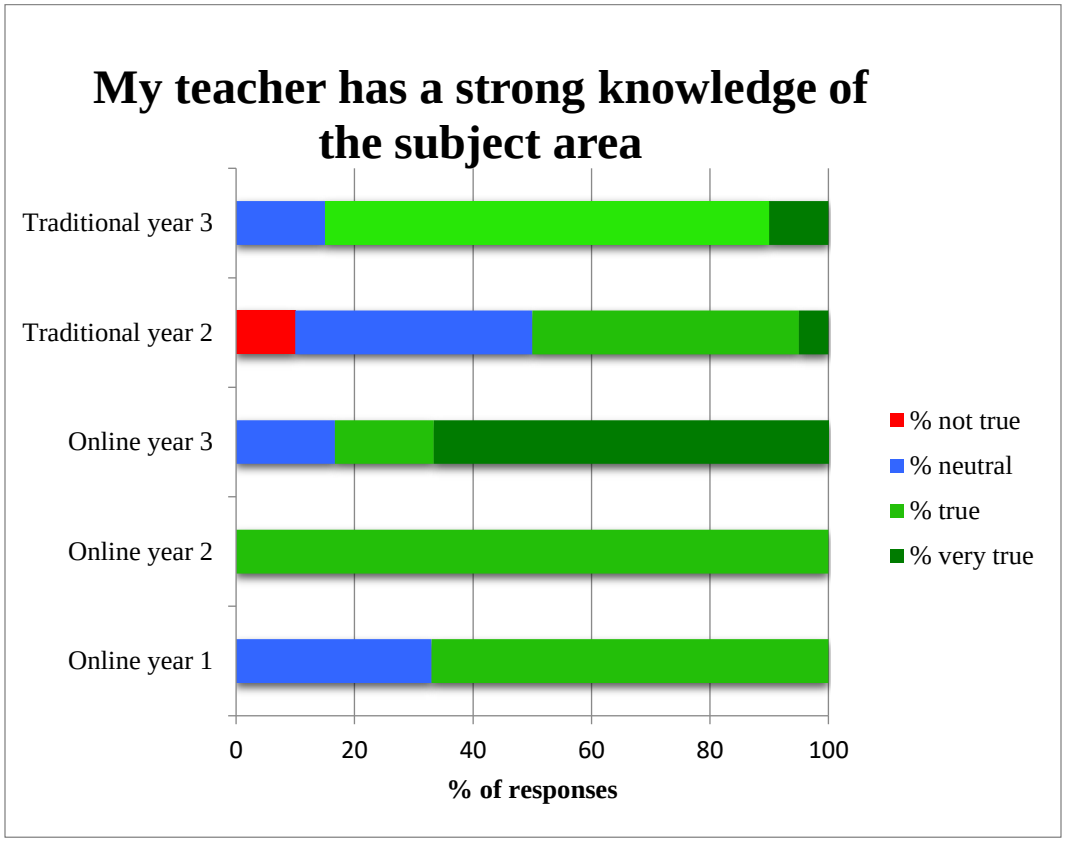


Figure 2. Survey responses to question #1 “My teacher has a strong knowledge of the subject area.” (Online year 1 *N*=9, Online year 2 *N*=4, Online year 3 *N*=6, Traditional year 2 *N*=26, Traditional year 3 *N*=17).

Survey responses indicate students felt the teacher had strong knowledge of the subject area (Figure 2), with 100% of year three online respondents strongly agreeing and 75% of traditional year three respondents agreeing. Survey data and student quotes correlate exceptionally well with the last four years of professional development (Table 8). An online student noted, “I never raise a question unsure whether Liz will know the answer or not; she ALWAYS knows. And she goes beyond the material of the

curriculum when talking to us, and is constantly pushing us to think further." A traditional student added, "I like the bioblitz activities and inaturalist projects that have been added to the class. When we are outside in the field I love being able to ask Liz questions about ecology and the organisms we are seeing. She has a vast knowledge of local species and ecosystems."

Table 8
Professional Development Liz Gottlieb 2013-2017

Year	Professional Development Description	Content
Summer 2013	High Sierra Climate Change Pika Backpacking Traverse	Naturalist skills Climate Change Field studies / Journaling
Summer 2014	American Prairie, Montana Backpacking Outing	Naturalist skills Field studies / Journaling
Summer 2014	Streamside Science MSU	Field studies / Journaling Learning an online approach to field studies
Fall 2015	Insect-ology MSU	Online teaching & Learning approach to entomology
Summer 2015	Microbial Genetics MSU	Microbial Genetics Online teaching & learning
Summer 2016	Flowering Plants of the Northern Rocky Mountains Field Course	Field studies / Journaling
Summer 2016	California Naturalist Certification Field Course	Field studies/Journaling California ecology applied locally, iNaturalist
Fall 2016	Macrolichens of the Bay Area	Field studies/journaling Microscopy, iNaturalist
Fall 2016	Marin bird surveying; citizen science project	Field studies, iNaturalist
Summer 2014-Summer 2017	MSSE: Masters of Science Education	Thesis: "How does developing an online field ecology course to support high school students impact my growth as a teacher?"

Figure 3 illustrates the number of times each group evaluated the teacher, course and activities. During 2014-2015, traditional and online students completed four evaluations. By the 2016-2017 academic year, the traditional group evaluated activities ten times compared to never in the 2014-2015 year. While students in online ecology in the fall of 2016 were evaluating activities (5), teacher (3) and the course (3) almost three times more than the first year of the course.

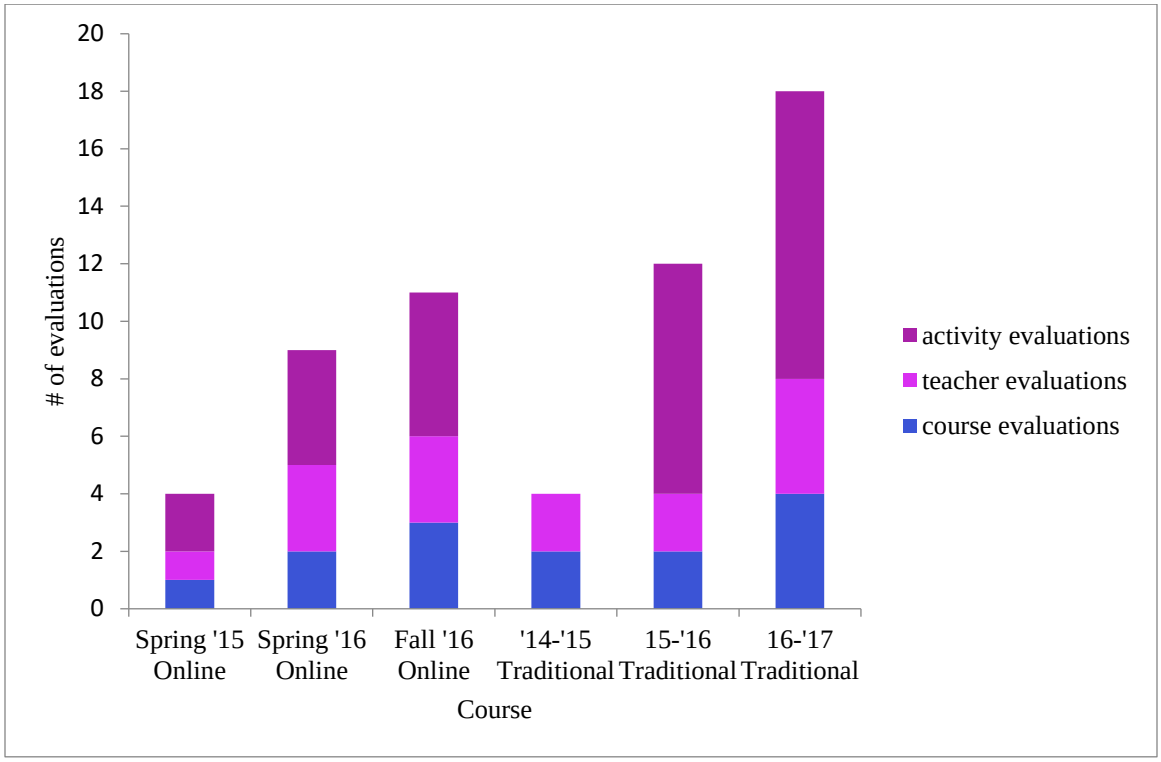


Figure 3. Change in number of surveys distributed in online ecology and traditional advanced biology (2015 -2017).

The increased use of surveys in all courses played a direct role in how I was able to reflect and refine my courses and teaching practices as demonstrated by this quote from my teacher journal:

> Moreover, the feedback from student surveys helped me to refine and reflect on new teaching practices and structures that I have added to my traditional courses.

> Open-ended comments from students raised new questions for me with respect to my effectiveness as a teacher. I also found data from student evaluations and surveys as a great way to collaborate with colleagues. I asked colleagues for help in interpreting some of the open-ended survey responses and checked in with them with respect to how I interpreted feedback from students. I was able to use these conversations with colleagues to help inform how I could continue to make changes to my courses, like adding new technology (Peardeck, Google Earth) and changing homework practices (kits and screencast videos) to help enable students to learn more effectively. (Appendix E)

Student comments support some of these comments reflected in the teacher journal. On one open-ended survey question in the fall of 2016, an online student remarked on the role that surveys can play in teacher responsiveness, “Liz is always looking for ways to improve the course. She gives us surveys all the time and wants to get our feedback.” A traditional student noted, “I feel like Liz really listens to our feedback when we fill out surveys. She is able to adapt the course to our needs and interests while still maintaining a challenging atmosphere.”

In order to understand how my online teaching impacts my traditional teaching, pre and post tests were analyzed and changes made to the gall ecology lesson as a result of teaching online were identified (Figure 4). There are three teaching practices transferred from online to traditional teaching; use of science notebooks, kits and screencast videos and the use of technology such as Peardeck.

The online group‘s median pretest score was 58.5 compared to the traditional group’s median pretest score of 33 (Figure 4).

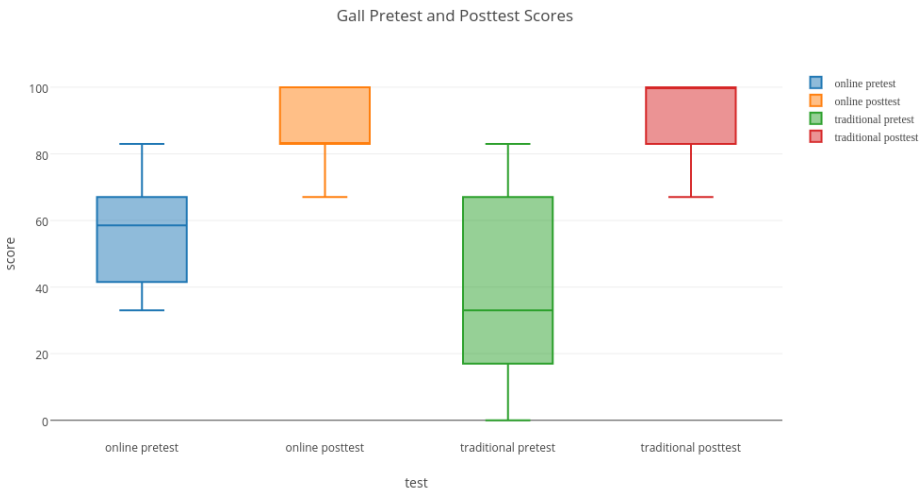


Figure 4. Gall pretest and posttest scores for online ecology (*N*=9) and traditional advanced biology (*N*=17) courses.

Post test data, demonstrates a high level of success with both groups (mean posttest of 83 for online and traditional). However, according to the Hake classification of normalized gains, the traditional group's gain of .75 rates is high, while the online gain of 0.625 is rated as medium learning (Figure 5).

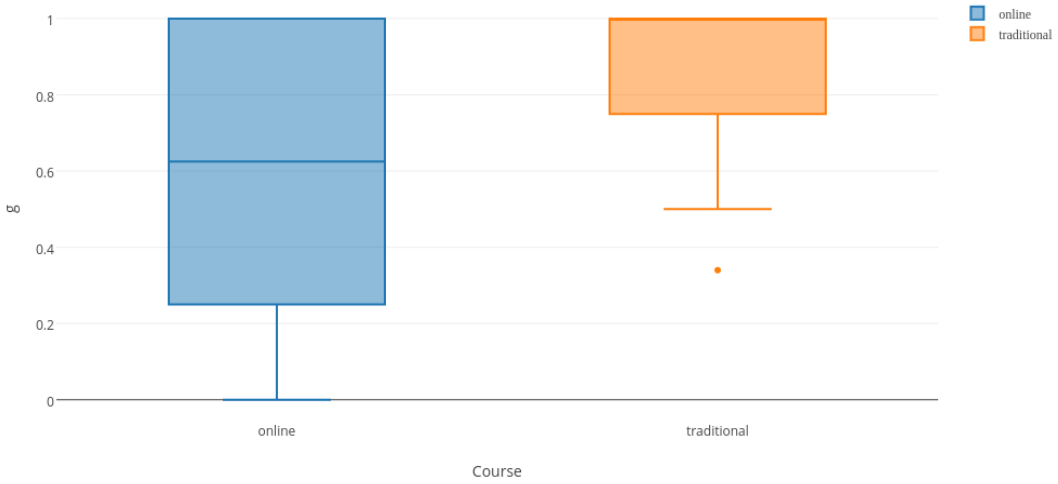


Figure 5. Normalized learning gains in gall study for online ecology, (*N*=9) and traditional advanced biology courses, (*N*=17).

Traditional student responses regarding their experience with the gall lessons were positive.

> I really liked how hands-on the lesson was, as we studied our very own galls. I liked that the lesson was at my own pace so when I wanted to stop and think I could just pause the video. I think the teacher was very enthusiastic in her explanation of galls and the videos were especially interesting.
>
> I really liked the combination of online and in person learning. Checking in and confirming ideas in class after observing the galls was a positive experience for me.

When the traditional students were asked to indicate their favorite part of the lesson; gall ecology, screencast video, Peardeck review, journal observation or other, 31% of students indicated that the screencast video and 38% of students identified the gall kit as their favorite component of the lesson (Table 9).

Table 9
Advanced Biology (Traditional students) Indicate Their Favorite Part of Gall Lesson (N=16)

Gall lesson Component	%
Gall kit	38
Screencast video	31
Peardeck review	25
PPT on Gall ecology	0
Science notebook observation	6
Other	0

Even though for this particular lesson on galls, science notebook observations did not rank as student's favorite activity the addition of science notebooks to my traditional

teaching practice is a change since teaching online (Table 7). As shown by Figure 6, students in traditional courses had variable experiences using notebooks in this class. While students in the online course had more favorable experiences using notebooks. One student in the online course summarized the impact science notebooks had by saying;

> I have never been required to keep a science notebook in any class. This practice has helped me grow as a learner and scientist. I like how I can review my work and see my growth as a field biologist really clearly with this journal. I also love seeing how much I am learning by reviewing my sketches and observations.

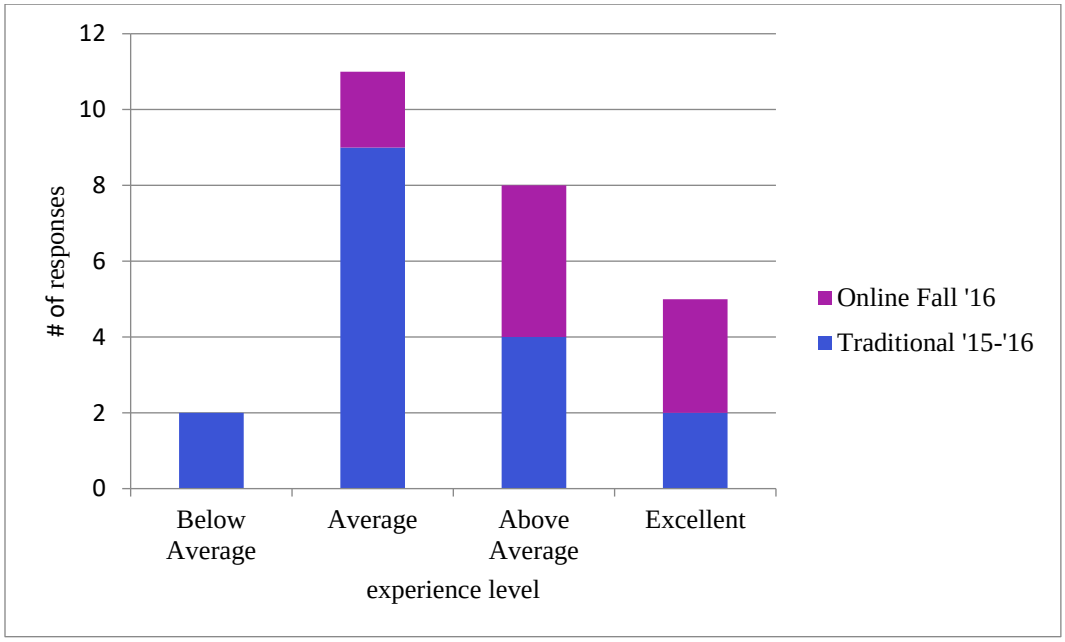


Figure 6. Student experience using science notebooks in online ecology (*N*=9) and traditional advanced biology (*N*=17) in the fall 2016 semester.

I surveyed other trans-classroom teachers to answer sub question 3 about how my growth as a trans-classroom teacher was similar to the growth and experience of other trans-classroom teachers in online consortiums (Appendix H). Figure 7 illustrates responses to question #5 on the trans-classroom teacher survey.

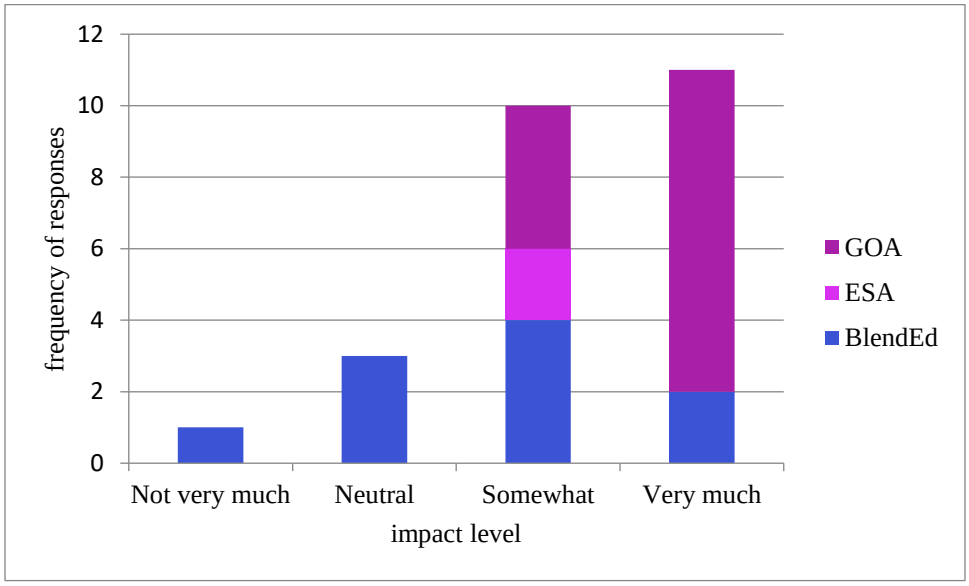


Figure 7. Survey responses to question #5, Impact of online teaching on face-to-face teaching, "Overall do you feel that teaching online has a positive impact on your face-to-face teaching?" (BlendEd cohort *N*=10, ESA cohort *N*=2, GOA cohort *N*=13).

The majority of participants surveyed (88%) replied that their online teaching "somewhat" or "very much" positively impacted their face-to-face teaching.

In my teacher journal a number of teaching changes are described after becoming a trans-teacher,

> For example, I have eliminated poorly designed lessons in my face-to-face classes. I have redesigned and added lessons in my face-to-face classroom to optimize the time I have with my students in person. I think my lessons are even more student focused in my face-to-face classes because I appreciate the time I have with the students in person. I feel like I challenge my face-to-face students more because I know what students can do independently due to my experience teaching online. Moreover, I consistently provide more timely feedback since teaching online. I feel compelled to give my online students swift feedback so that they are heard and can apply my feedback to their next assignments. I found myself sometimes neglecting this timely feedback in my face-to-face classes, prior to teaching online however, since teaching online I now adopt this same turnover rate to my face-to-face classes and the students have responded well (Appendix E).

When examining changes my colleagues have made in their face-to-face courses since teaching online there are a number of similarities; 70% of teachers surveyed eliminated poorly designed lessons and 50% of teachers redesigned lessons (Table 10).

Table 10
Changes to Face-to-Face Courses Since Teaching and Designing an Online Course (*N*=20; ESA=1, BlendEd=7, GOA=12)

	% No Changes	% Changes
Course Organization		
More Advanced planning	40%	60%
Used class time more efficiently	55%	45%
Provided additional scaffolding for large projects	30%	70%
Course Design & Redesign		
Eliminated lessons that now seemed poorly designed	30%	70%
Redesigned lessons using Backward Design principles	50%	50%
Communication		
Made instructions clearer/more explicit	35%	65%
Made key concepts clearer/more explicit	40%	60%
Used an online discussion forum in my classes	45%	55%
Provided more timely feedback	70%	30%
Found additional ways to monitor individual students	35%	65%
Found ways to give students more time to formulate answers	45%	55%

In an effort to address credibility, six participants were asked to review collected data and my interpretation (Table 11). All participants surveyed agreed or strongly

agreed with the data and my interpretation. When participants were asked what additions or corrections they would add to the interpretation of the data they provided valuable feedback:

> What is the average number of years teachers surveyed have been teaching? and Is there any correlation between teaching experience and teacher change?
>
> Did you find any trends related to how student centered teaching changed as teachers migrated between online teaching and face-to-face teaching?
>
> Was it easier for teachers to transfer teaching strategies between online and face-to-face classes if the courses were the same or similar?
>
> What is next for you and your own professional development? Will you continue online professional development or continue to participate in leadership opportunities related to BlendEd learning?
>
> Your findings are similar to other studies that I have read related to teachers who work simultaneously in face-to-face classes and online classes. Well done.

Table 11
Member Checking Data Analysis Level of Agreement, (N=6).

	Strongly disagree	Disagree	Agree	Strongly agree
Quantitative data			85%	17%
Interpretation of the data			66%	33%

INTERPRETATION AND CONCLUSION

The potential for online environments to benefit teaching and learning has been a thought-provoking discussion over the last 20 years. The transfer of practices from online teaching to face-to-face teaching classrooms have been reported in evaluations of programs like Virtual High school (Dikkers, 2015) and Kentucky Virtual High School (Treacy, 2007).

Over the last three years, I have made changes to my teaching practice as a result of my transition to teaching online. Online teaching made me a more responsive teacher. The increased use of surveys to evaluate courses, teaching and activities helped me respond to student experience, feedback, and questions more often. In my online courses I found myself looking for as much feedback as possible to help me support my students that were at a distance. I carried this practice over to my traditional classes and discovered that I could make changes to classroom practices that impacted students directly and immediately.

Additionally, developing an online ecology course inspired me to dig into professional development that ranged from field work in Montana, to becoming certified as a California Naturalist to completing my Master of Science in Science Education through Montana State University. My students across the board were able to benefit from these opportunities I had to learn and be a student again. My fieldwork is stronger as a result and I am incorporating new technology such as Peardeck, citizen science apps and screencast videos into many of my classes.

Through developing an online course I discovered the value of citizen science as a tool for students to participate in local, relevant science projects. Since discovering citizen science I have incorporated citizen science, like inaturalist bioblitz projects, into my traditional classes. This tool in particular speaks to a very specific way my teaching practices have changed since teaching online. Below is an excerpt from my teaching journal that reflects the value citizen science has had on my teaching.

> I don't think I would have explored citizen science projects as rigorously prior to teaching online. The collaborative nature of many citizen science

> projects with peers, community members and experts has always been appealing to me. Moreover, collaboration has been something I wanted to work harder at establishing in my online course because I could not directly facilitate it as I would in a traditional classroom. Mary Ellen Hannibal, talks about citizen science as being a platform for change and an opportunity to see without the old blinders in her book, "Citizen Scientist". Citizen science allows amateurs and naturalists to join forces and help promote biodiversity and respond to extinction and invasive species migration. It has been exciting to participate in projects with students that demonstrate how science is changing. Science is much more collaborative and transparent right now in light of crowd-sourcing data collecting tools like iNaturalist. Moreover, the opportunity to empower students to participate regularly in data collection and connect with nature have been especially transformative and joyful for me as a teacher. It is fun to see students engage with things they are comfortable with already (phone apps) and use this (app) as a tool to learn more about their communities and our earth (Appendix E).

Similarly, developing an online field ecology course marks my entry into using science notebooks in all of my courses. The practice of using science notebooks regularly in all classes has helped me to emphasize the process of science and has been a marked change in my practice. Student experience in all courses using science journals was positive. As shown by student reflections related to their science notebooks the use of notebooks helped students reflect more on their own skills and growth as scientists. This sentiment is reinforced by this traditional student's comment, "I feel like a scientist using my notebook regularly." My teacher journaling reinforced the value that science notebooks have fostered by facilitating more opportunities to practice learning and the power of student reflection to make change. When students have the opportunity to reflect on their work and make changes and try again, this builds confidence and skills.

When traditional students reflected on the way they used their notebooks for the alpha Fast Plant study and then how they made changes in their beta studies they had the following comments:

Comment 1:

> After completing the second round of the Fast Plant experiment, I learned the importance of organized data collection. With our initial experiment, I was messy and did not keep my data in uniformed tables. When it came time to put together my findings, the data I collected was unorganized and uniform. By redoing this experiment, I realize that in science you cannot always be satisfied with one trial or test. It is important to learn from your mistakes and further refine experiments so that the best data can be collected. With the initial experiment I was unsure at times when to collect data or make observations. The second round helped me learn from my mistakes and become more confident with my scientific abilities (Appendix E).

Comment 2:

> I have gained a new appreciation for the intricacies of not only the process of science in terms of performing experiments, but also of thorough and premeditated organization and clear communication (Appendix E).

Comment 3:

> ...the notes (journal data), on the whole, were far better than last semester's, and I believe that to be because of the practice that we had, and the amount of reflection that we did after the first semester project was over. Not only did we have a larger amount of data (second semester) but the data was cared for more intensely (Appendix E).

Comments in my fall teacher journal (Appendix E) illustrate teacher change and growth:

> I feel like I am a better teacher/coach using notebooks regularly. I feel like I have windows into my students' science training by using notebooks. It is easy to fall into using summative assessments regularly to monitor progress however, the beauty of science journals and notebooks are that these assignments are low stake and great ways to assess learning in process (formative assessments). Reviewing student work in these

> journals is a great way to monitor student learning and to identify where students are struggling, or succeeding and to learn more about what interests them (Appendix E).

The use of science notebooks enhanced opportunities for me to informally assess student work in process. Science notebooks ultimately helped me create environments in my classes (online and traditional) for students to learn, make mistakes and to practice science. This structured and transformative time for students to reflect on their work and process has been largely facilitated through the use of science notebooks as a tool to look back on work and make goals to continue growing and learning. This brings me back to key components that Scarborough and Ravaglia discuss when talking about the SOHS and how a key component of education is to teach students how to think and how to learn.

Furthermore, by developing an online course and reflecting on my teaching online and traditional, I have changed the way I give summative assessments. Across the board I give more lab practicals in all of my classes. I have replaced unit tests with lab practicals in my traditional courses. This shift was a direct result of a change I made between my first (spring 2015) and second year (spring 2016) teaching online ecology. During the first year of online ecology students completed an end of the year project. However, during the second year of the course students completed a mid term exam and a final certification test. A student in the online spring 2016 course had this to say regarding the change,

> A little pressure on the certification tests goes a long way for me. This helps me take the course and content seriously and gives me a clear goal to work towards. I liked having a list of skills I had to know how to do; like

> knowing how to use a clinometer and a compass and I loved learning how to identify and be accountable for so many local species.

Whereas, in 2015, when the course had no midterm nor final certification, a student surveyed about the rigor of the course said, “A little too easy. I felt like my grades were high I could have been pushed more. I was able to complete the final project in just a few days even though we had six weeks to complete it.”

This action research study also aimed to demonstrate how my online teaching impacted my traditional teaching (sub question 2). In 2008, Lowes found that three quarters of trans-teachers reported that their online teaching had a positive impact on their traditional teaching (Lowes, 2008). My gall lessons with my online and traditional classes illuminate how online teaching has inspired me to employ multiple new techniques in my traditional classes such as hands on learning experiences through kits, creative and flexible approaches to assessments and new strategies to deliver content (videos and Peardeck presentations). The formal observation instrument (Appendix E) shines a light on the multiple ways (verbal, electronic, and visual) I asked students during my face-to-face lesson to explain what they knew about galls. The ability to bring in more interactive tools, like Peardeck, into my traditional classes to assess student learning is a result of working on my online course. Formal observation comments made by my colleague suggest some of the advantages of using new technology like Peardeck in my traditional classroom.

> One key difference I noted from other online tools such as Socrative was the ability for students to change their answers after their first submission. You were then able to give more context or explanation to each question and see the development of the student answers with your discussion, getting instant feedback and adapting to the needs of the students. I

> believe this would help to foster a growth mindset in your students. Nicely done. (Appendix G)

When traditional students were asked to evaluate the gall ecology lesson four students identified the use of Peardeck in the classroom as a highlight. One student said, "I liked that Liz didn't just reteach the lesson or ask us to explain what we learned to one another or her. I thought Peardeck was interactive and fun. I loved how different it was compared to a typical lesson."

Moreover, online teaching has allowed me to bring the flexibility and individualization of online learning to my traditional classroom. When I asked my traditional students to participate in a flipped video lesson on gall ecology, one student commented, "I liked the lesson because I was able to learn at my own pace." A strategy that is common in online learning is giving students more control over the time, place, path and/or pace of their learning.

Similarly when students were surveyed about what it was like to take home a gall kit to study, observe and journal about, student feedback was strong. A student in the traditional class summed up the experience well by saying, "I felt like I was going home with a present. I was excited to explore the bag of organics and learn something new by myself and at my own pace. I haven't felt this excited about homework for a long time."

The gall ecology lesson shows off many practices; homework kits, science notebooks, Peardeck, that I was able to transfer from my online course to my traditional courses. These are practices that I plan to continue to use and develop. Ideally, I would

like to seamlessly cross modalities and combine the best of online and face-to-face practices into all of my courses.

I was also very interested in finding out if my experience as a trans-teacher was similar to other teachers who migrated between online and face-to-face teaching (sub question 3). As demonstrated in Figure 6, 88% of teachers that I surveyed indicated that their face-to-face teaching was somewhat or very impacted by their online teaching. There are many specific things that I have in common with teachers I surveyed in terms of changes to our teaching practices. Like, 70% of teachers that I surveyed, I have eliminated poorly designed lessons in my traditional classes since teaching online. Many of us have redesigned or added lessons in our face-to-face courses to optimize and use the time more efficiently. Similarly, 65% of teachers surveyed indicated that their instructions are more explicit and clear since teaching online. The excerpt below from my teacher journal reflects similar findings.

> I certainly think I communicate more effectively with all of my students due to my foray into online teaching. Online teaching requires more detailed explanation. I feel like I am more specific in my assignments across the board with my face-to-face students and my online students. Teaching at a distance, I found that sometimes even simple directions can seem overwhelming to students. I have learned to explain concepts more clearly and provide more examples to demonstrate expectations (Appendix E).

A common challenge that all teachers surveyed, and that is described in my teacher journal, have when it comes to the first year teaching an online course is time. Across the board multiple participants surveyed mentioned time and time management as obstacles: “A terrific amount of time that I was not expecting. Very, very

time consuming." Moreover, another teacher poignantly added, "Creating time to get to know my online students while not neglecting my face-to-face class,", as a challenge.

Teacher reflection has been an important component of my growth as a teacher over the last few years. In my teacher journal (Appendix E) I describe this in the following reflection:

> I think developing an online ecology class and reflecting on the process over the last three years through this master's program has helped me to try new strategies, learn from my reflections, and engage rigorously with continuous growth as a teacher, citizen and student.

I am not alone with respect to the power of reflection to inspire change. When teachers were asked how they have grown professionally by developing and teaching an online course they replied, "I'm reflecting on practice. I'm refining how I structure, communicate, participate and interact, etc." and "I'm better at reflecting on my own teaching" and, "I reflect so much more on my teaching practices and I use these reflections to help me make changes that will impact my students' growth and learning." It is interesting to note that by changing the medium of how we are teaching, many trans-classroom teachers have found themselves engaged in more reflection, leading to improved or new teaching practices.

An observation that I have in my teacher journal is the idea that I have found myself challenging my traditional students more because I know what my online students do independently online. I did not specifically address this in my survey to my trans-colleagues. This is something I want to dig into more and ask my trans-colleagues about moving forward. Like many of my colleagues, I provide more timely feedback in all of my classes now. Finally, many teachers who have migrated to teaching online have

found the experience to be liberating. The opportunities that online teaching opens up allows teachers to experiment and be more innovative. Trans-teachers that I surveyed reported the following successes teaching online:

> It was fun to experiment with my online class and be more innovative!
>
> My online class inspired me to take risks and ask students to take on large scale projects I had never implemented before.
>
> Connecting with experts, both virtually and in person, was a highlight of my online teaching.

I have benefitted greatly from all of the professional development opportunities I have had over the last four years and I have been able to incorporate more citizen science and longitudinal science experiments into all of my classes. Like others, I have certainly found online teaching to be a chance to reinvent myself professionally.

VALUE

This action research project helped me to document my growth as a trans-classroom teacher. Developing an online course opened up a wide range of professional growth opportunities for me that all of my students (traditional and online) were able to benefit from. Online teaching has inspired me to apply many new teaching practices that I use with my online students to my traditional students. These practices have diversified and transformed the way I facilitate homework, discussions and assessments.

Moreover, this action research project raised new questions related to course development, trans-classroom teacher development, citizen science projects and future areas of study. Multiple participants in the trans-classroom teacher survey discussed how much time and effort it took to develop their online course. These same teachers also described varying levels of support they received during this process. One trans-

classroom teacher suggested having a master online teacher for support during the course development process would have helped a lot;

> I spent so much time trying things out when I was developing my course. I also felt isolated because I was only around my colleagues who all taught traditional classes. I think if I had a master online teacher to collaborate with the experience would have been much more favorable. I definitely felt like I was inventing my own way of doing things and really could have benefitted from someone else's experiences.

I can relate to these comments. As part of my role as BlendEd Coordinator for my school, I would like to play an active role in supporting new teachers who migrate from traditional classes to online classes.

Additionally, there were a number of insightful comments from students related to the benefits of citizen science projects. This comment from a student survey introduces new questions about the role that citizen science can play in traditional and online courses.

> …I love using inaturalist. I am "meeting" so many local experts, insect gurus, fanatical birders, fungi specialists! All of these local experts have helped me expand my awareness of local species and organisms! I am learning so much from these people I have never met. I am communicating with people I don't get to engage with in my daily life.

Participating in citizen science projects with my traditional classes at Marin Academy has allowed me to leverage local resources like the Academy of Science and local scientists seamlessly and collaboratively. Moreover, many citizen science projects have components that allow one to collect, manage and analyze lots of data. Data from these projects can be built into courses and students can play a role in leaving a legacy of data

for future classes to explore, manipulate and build upon. I have started to collaborate with local scientists to create longitudinal projects that local schools can participate in.

Moreover questions raised by the member survey suggest additional areas to explore in future studies. For example, I did not dig into what variables might affect teacher change; like how much experience teachers have teaching, how similar their face-to-face courses are compared to their online courses, and whether or not the teacher developed the online course or inherited an established course. I am optimistic I may learn more about these variables as I continue to work with new trans-classroom teachers.

My goals for the near future include finding more ways to connect with trans-classroom colleagues across the country at national conferences. I had the opportunity to present my online professional growth to my colleagues during a faculty meeting (February 24, 2017). I also presented at the Online/Blended Education Symposium for Independent Schools (OESIS) National conference in Los Angeles on February 22 and February 23. I would like to continue to share my work and findings with peers locally and nationally. I also want to continue practicing science in the field by participating in citizen science projects and attending field workshops around the Bay Area. This capstone research project has invigorated my teaching practices.

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APPENDICES

APPENDIX A

TEACHING ASSIGNMENTS AND RESPONSIBILITIES LIZ GOTTLIEB

Year	School	Teaching	Other
1997-1999	Roosevelt Middle School	6th, 7th & 8th grade Science	Volunteer track and field coach
1999-2000	Marin Academy	9th grade Biology,	Assistant XC & Track and Field Coach
2000-2002	Marin Academy	Integrated Science I (Biology and Chemistry 9th grade), Integrated Science II (Biology and Chemistry 10th grade)	Dean of Multiculturalism, Head XC & Track and Field Coach
2002-2012	Marin Academy	Integrated Science, 9th Biology	Head XC & Track and Field Coach
2004	Marin Academy	9th Biology, Environmental Justice	Head XC & Track and Field Coach
2007-2012	Marin Academy	AP Environmental Science, 9th Biology, Advanced Biology	Head XC & Track and Field Coach
2012-2015	Marin Academy	Thoreau Chair, Advanced Biology, AP Environmental Science, 9th Biology	Thoreau Sustainability Chair, Head XC Coach
2014-2015	Marin Academy	Advanced Biology, AP Environmental Science, BlendEd Bay Area Field Ecology	Head XC Coach
2015-2017	Marin Academy	Advanced Biology, AP Environmental Science, BlendEd Bay Area Field Ecology, Exploring Experimental Design	BlendEd Site Coordinator

APPENDIX B

EDUCATION AND CAREER DEMOGRAPHICS LIZ GOTTLIEB

Year	Institution	Study
1993-1997	Colby College	Biology major
1997-1999	Teacher for America	Middle School Science teacher Compton, California
1999	Loyola Marymount	Graduate courses; Loyola Marymount University/Teach for America partnership
1999-2017	Marin Academy	Science teacher • 18 years biology • 10 years AP Environmental science & advanced biology • 3 years BlendEd online field ecology • 1 year environmental justice • 1 semester 10th grade exploring experimental design
2002-2004	University of California, San Francisco	Graduate courses; urban education and social justice
2014-2017	Montana State University-Bozeman	Master of Science in Science Education

APPENDIX C

ONLINE ECOLOGY SURVEY

	Student Level of Agreement				
Question:	**5 – Very true**	**4**	**3 – Neutral**	**2**	**1 – Not at all true**
Teacher feedback					
1.My teacher has a strong knowledge of the subject area.					
2.My teacher is well prepared for the course.					
3.My teacher makes good use of resources.					
4.My teacher showed significant enthusiasm for the course.					
5.My teacher provided prompt feedback.					
6. My teacher provided helpful feedback.					
7. When compared to my face-to-face courses, my personal connection with my BlendEd teacher was weaker than the connection I have with my face-to-face teachers.					
Course structure					
1a.When compared to my face-to-face courses, my BlendEd course was easy to navigate					
2a. When compared to my face-to-face courses, my BlendEd course was more rigorous.					
3a. When compared to my face-to-face courses, my BlendEd online discussions added significant value to the course.					
4a. When compared to my face-to-face courses, my BlendEd onsite field trips added significant value to the course.					
5a. When compared to my face-to-face courses, the online assignments were clear and I knew what the teacher expected me to do.					

APPENDIX D

TRADITIONAL BIOLOGY SURVEY

	Student Level of Agreement				
Question:	**5 – Very true**	**4**	**3 – Neutral**	**2**	**1 – Not at all true**
Teacher feedback					
1.My teacher has a strong knowledge of the subject area.					
2.My teacher is well prepared for the course.					
3.My teacher makes good use of resources.					
4.My teacher showed significant enthusiasm for the course.					
5.My teacher provided prompt feedback.					
6. My teacher provided helpful feedback.					
Course structure					
1a.When compared to my other courses, my Advanced Biology course was easy to navigate					
2a. When compared to my other courses, my Advanced Biology course was more rigorous.					
3a. When compared to my other courses, the assignments were clear and I knew what the teacher expected me to do.					
4a. Compared with other courses I have taken I have benefited from this course a lot.					
Open ended Questions					
1b.What's one thing you would NOT change about Advanced Biology?					
2b.What's one thing you would CHANGE about Advanced Biology?					
3b.What's one thing you would NOT change about Liz's teaching?					
4b.What's one thing you would CHANGE about Liz's teaching?					
5b Are there any teaching styles, structures or practices that Liz delivers that are unique or different compared to other teachers at MA? Explain.					

APPENDIX E

TEACHER JOURNAL

Journaling related to Gall Ecology lessons

October 18, 2016

What? :PreGall Study with BlendEd students.

Lesson: Presurvey, Video, PPT, and Journal observation

Post assessment (Formal Observation Instrument and Postsurvey 12/5

(What do I do?), describing

I prepared a lesson for my online students related to galls. I created a video and powerpoint to help introduce the content. I also sent students "kits" with galls to study. Each student had at least three different galls to study and observe as they went through the lesson. Finally I created a pre and postsurvey to examine how much content students picked up during the lesson.

I included this lesson in a unit that was already prepared related to Insects. During the first two years of the course I taught this course in the spring and this was my first time teaching the course in the fall. I had more experience pointing out insects that were emerging and prevalent in the spring than in the fall, so I thought the gall structure would be a great way to incorporate insects and ecology into this unit.

Also, I selected this lesson on galls to implement with both my online and traditional classes. The ecology of galls connects directly to content we discuss in Advanced Biology first semester. My initial hypothesis is that I may be able to follow up with more content and questions with my face-to-face students related to galls than my online students because I see my face-to-face students more regularly and I can read and review their reactions to the content in person.

(What does this mean?), informing

I wanted to find multiple ways to introduce students to galls. I know that on our first face-to-face outing in Pt. Reyes, I pointed out galls to some groups of students and they seemed interested. However, I was not very confident that students recognized galls in their environments regularly and/or appreciated their role in the ecosystem.

I also found myself looking for new ways to teach content during a different time of year. I think galls are a great fit any season because they are visible on trees all year long.

(How did I come to be like this?), confronting

Every year and probably day, that I teach online I try to come up with new ways to engage and reach my students. During my first year of teaching online, I feel like I just tried to replicate strategies that I used in my face-to-face classes. For example, I would ask students to read and interpret articles and submit reflections on these articles. Likewise, I would ask students to collect and share data. However, as my experience grew as an online learning and teacher, I started to try new things that I don't do in the classroom. I started to create screenflow videos for my online students. I also started to experiment with the kits that my online students had for the course. Initially I designed my online blendEd field ecology like the streamside ecology course that I took at MSU. I created a kit with tools for my students to use throughout the semester. However, as the course developed, I realized there were additional elements I wanted to add to the kit like lichen samples and galls. During the third "run" of the course, I added samples of lichen and galls for the students to observe and study.

October 30, 2016

What? Part 1 of gall lesson deployed! Students have done presurvey, video, ppt and journal entry.

Lesson: Gall Lesson

(How might I do things differently?),reconstructing

One of the first things I considered after deploying this lesson online was how I can continue to incorporate gall observations into my future face-to-face field trips with my BlendEd students. Likewise, I see so many applications and connections to our Advanced Biology content in our genetics and evolution unit. I think noticing and observing galls in one's environment is a great way to start to interpret the ecology, climate and local ecosystem dynamics.

I will not deploy my postsurvey with my BlendEd students until the final class. During the final class students will take a certification test and a component of that test will be on galls. During this portion of the test, a colleague will fill review my teaching through a formal assessment observation instrument. Students will be asked to explain galls and gall interactions to a partner. Liz will evaluate each individual during this time. In the future, I think I would include this post assessment closer to the gall unit/content. However, I do think for this iteration it will be interesting to test it out as a component of the certification test which serves as the final.

November 16, 2016

What? :PreGall Study with Advanced Biology classes.

Lesson: Presurvey, Video, PPT, and Journal observation

(What do I do?), describing

I asked my Advanced biology classes to review and participate in the lesson I created for my online students related to galls. I created a video and Powerpoint for the blendEd students that I wanted my face-to-face students to watch. I also sent my Advanced Biology students home with two galls to study and to complete a journal entry on. I created a pre and postsurvey to examine how much content students picked up during the lesson.

In addition, I created a check in Peardeck PPT to assess how the students did with the homework. My department head will observe me during class and use the Formal Assessment observation instrument I created for my action research project.

(What does this mean?), informing /(How did I come to be like this?), confronting

I am curious how a lesson I designed for my blendEd class will land and go over with my face-to-face students. There is an added benefit that I will see my students the night after they have completed the gall assignments. I will also be able to get feedback on the learning materials and content very quickly. Moreover, my colleague will observe me and give me feedback based on how I am checking with students' learning targets, monitoring classroom discussions, providing feedback and moving students forward and helping students take responsibility for their own learning.

I also see many ways that gall content relates to our studies in Advanced Biology. I am curious how this content will land with students in this class. Students who are in this class selected this course over blendEd online options and other life science electives at our school.

One element that will be interesting to observe is the notebook observations/entries that my Advanced Biology students make about galls. I started incorporating field books into my Advanced Biology class after working with field notebooks for my online blendEd course. I realized I had lost the practice of teaching journaling and field skills to my face-to-face classes and I wanted to bring it back. Typically, I ask students to observe something under an umbrella theme. For example they may need to journal about evolution. They can observe a tree, dog, ant, river and then ask questions that relate to sequences of events that gradually take place over time (Evolution). Often, my face-to-face students, like the open ended but structured nature of these journal observations, however, sometimes they complain that they couldn't find an example. For this assignment, students will be sent home with galls to observe and study. There is an element of convenience that I hope they appreciate. Will their entries be even better because their specimen is in their hands?

November 17, 2016

What? Gall lesson deployed in Advanced Biology class. Department head completed formal observation instrument.

Lesson: Gall Lesson

(How might I do things differently?),reconstructing

The class before this gall lesson, students had a genetics test. After the test, I asked students to fill out a pregall survey. I was really surprised how uneasy students were in class when they had to answer questions on the presurvey they were not familiar with. Multiple students came up to me while they were in the middle of the survey asking what they should do if they had no idea what the answer was. I realized that my face-to-face students are not used to being in the position where they don't know anything. If I give another "random" survey I will preempt the survey with an announcement that clearly illustrates that I don't expect them to know any of the content and they may get 0% and that is ok! There is no consequence.

Although the Peardeck review was fun, the students do need their computers or a device out to participate in the review questions. At least 2 or 3 students out of 10 were toggling back and forth between other web pages during our review activities. I find this distracting and I have questions about how much the students are getting out of the activity if they are multitasking. In my second Advanced Biology class I was very explicit that I wanted students only to visit the Peardeck site and to not answer emails or review other websites or messages during the activity. I noticed this helped moved the activity along more smoothly. I need to consistently remind my students what my expectations are clearly so I don't set them up for diversions or behavior that I don't appreciate.

Another thing I would change with my face-to-face review lesson is that I would take my students in the field to go over the information. If I did this, I would need to ensure that there are galls on campus and/or that I could take my students off campus to a site where there are galls. I think the hands on experience of seeing the galls on the trees in the field would help bring this lesson alive; more so than just getting a gall sent home in a baggie. If I did this, I could still potentially use Peardeck to engage the entire class in the field, but I might not want to depending on wifi and feasibility of setting everyone up with the proper device, etc.

Next year, I think I will continue to talk about galls with Advanced Biology, however, I will incorporate gall ecology into our evolution unit. I think there are so many interesting connections to this unit. This would help me get the students outside during this unit on evolution. I could also add a lab component related to galls to this unit as well.

December 5, 2016

What? Gall formal observation lesson deployed in BlendEd Ecology course

Lesson: Students will be placed in groups of 2 to 3 students and will need to complete a video related to gall ecology.

(What do I do?), describing

(What does this mean?), informing /(How did I come to be like this?), confronting

My observer, department head, was unable to come in and observe this lesson. At the last minute, I changed the format of this formal assessment and I decided to pair up students in my BlendEd ecology class and have them create videos related to gall content. I paired up students from different schools and they were instructed to make a 2 to 5 minute "Interpretive talk" video about gall ecology! I told the students to make an outline of what they were going to say and make 1 video, no edits. This would be an interpretive talk meant for an audience in the field.

https://www.youtube.com/watch?v=FMPD05cDSDw
https://www.youtube.com/watch?v=8GLeCdjsTWo
https://www.youtube.com/watch?v=ulWS6n2iCRQ
https://www.youtube.com/watch?v=3gBa_jZAe5I

I really liked seeing the students work together on this assessment. I also liked seeing the creative process and how students incorporated both content and naturalist skills (using artifacts like the gall and engaging with "audience") during the process. The students were all asked to complete the same task and I ended up with 4 different videos. I think this assessment ended up being better than what I asked my Advanced Biology students to do; answering questions together during a Pear Deck review session. I was able to see students apply what they know and work together so well in this format. I can also share this product with colleagues to inspire new lessons and ideas OR future classes to show them examples of what I am expecting.

(How might I do things differently?),reconstructing

Asking students to create interpretive talk videos about gall ecology turned out to be a great exercise. In the future I think I will include these interpretive talks into my final certification test every year, however, I will provide a menu of content themes that student pairs may have to present on. For example students might have to talk about gall ecology or oak ecology or the role fires play in our ecosystems or bird ecology. They will have a little time to prepare an outline and then they will present a 3 to 5 minute

interpretive talk with their partner on the last day. This isn't the first time students are giving an interpretive talk. During one of our face-to-face outings students had to come prepared and share an interpretive talk about the ecology or natural history of Mt. Diablo. The feedback from these talks and presentations was very good. I think asking students to deliver a second talk that is more formative is a great idea to continue to build presentation and naturalist skills. I also like that students have to collaborate with someone. I am excited to continue using this activity as a formative assessment in future years.

Moreover, the feedback from student surveys helped me to refine and reflect on new teaching practices and structures that I have added to my traditional courses. Open-ended comments from students raised new questions for me with respect to my effectiveness as a teacher. I also found data from student evaluations and surveys as a great way to collaborate with colleagues. I asked colleagues for help in interpreting some of the open-ended survey responses and checked in with them with respect to how I interpreted feedback from students. I was able to use these conversations with colleagues to help inform how I could continue to make changes to my courses to help enable students to learn more effectively.

PART 2: **JOURNAL Reflections Related to Scientific Notebooks**

BAFE Journal Reflection Fall 2016

Student experience with journaling in BAFE was mixed. Some students found the experience outside observing nature enjoyable and found the format accessible. However, some students felt stymied by the prompts and this led to an unfavorable experience. For example, if I asked students to observe fungi in the field and they were unable to find any, this was unsettling. I think I learned how to address this variable experience by setting students up with options for observation. They could observe organisms in the field or they could observe specimen that I sent them in "mini kits".

Regular journal entries helped me to provide consistent feedback to students. I was able to see how students' fieldwork and observation skills were progressing over time. I was also able to get more regular feedback regarding how helpful or unhelpful my comments were for students. I found that sometimes providing strong examples to explain expectations helped a lot in terms of demonstrating goals for the next assignment.

Moving forward, I will continue to incorporate and use field journals regularly in BAFE. I think the more flexibility that is built into these assignments the better. I also think it will be helpful to have each student make individual goals regarding how they want to grow with respect to their field journal work. Moreover, I want to show them more examples of scientific journals throughout the course to help model the process. A long

term goal is to show them how journaling can become a habit and a tool and a way of doing science.

Advanced Biology Field Journal Teacher Reflection 2015-2016

In the 2015-2016 school year I regularly began to incorporate field journals into my Advanced Biology coursework. Students had mixed views regarding how much they "liked" these assignments. They ranged from incredibly helpful, meditative, enjoyable to borning, challenging and forced. However, the majority of students really loved these assignments and found it liberating to get outside and do something different. Students said things like, "it was such a cool way to learn about the world around us", "I really liked drawing organisms and I made a lot of improvements as an artist and a scientist", and , "I loved journaling! I think it was a really good platform for us to explore the environment and apply concepts we learn in biology to nature!".

Moreover students had a lot to say about the format. Many students liked freestyle observations compared to overly structured assignments. For example, "I liked when there was not as much structure/requirements because I could get more immersed in the environment and what I was observing." Whereas a few students really appreciated the structure that was provided for some assignments, "I liked it when there was structure because sometimes without structure it is harder for me to find something to observe because there are so many possibilities."
What I found really interesting was how open students were to the process of journaling. By the end of the year, many students felt like they had grown as scientists specifically because they were more aware of their surroundings due to journaling. Another student said the journals were refreshing because, "I feel like many things in bio are designed to work out a certain way and we are just repeating experiments done hundreds of times. But this felt much more real and self-driven". This final comments speaks to some of the most important findings that I have gleaned from the use of journals in science classes. The journals allow more open ended inquiry and exploration for students. Moreover, the journaling can help students practice consistently the practice of science. Often times in science we have big labs and big lab reports. These formal summative assessments often have such big stakes (points) associated with them and may not fully capture the experience of students rather they depict one moment in time. I have really grown to like the regular feedback, coaching, interaction and check ins that are associated with field journals in Advanced Biology. These journals truly allow students to practice science in a low stakes manner and really master certain skills over time.

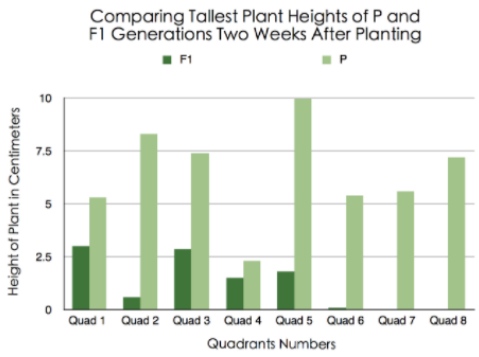
Advanced Biology Field Journal Teacher Reflection 2016-2017

In the 2016-2017 school year, I continued to use field journals for regular field observations outside of the classroom, however, I started to use a classroom scientific

journal for our work with Fast Plants. Students were required to keep a record of their data from our Fast Plant experiments in the fall and spring. At the start of the year, the plan was to just run one Fast Plant experiment. The goal was for students to act as plant breeders in an attempt to artificially select for a particular variable trait in a *Brassica rapa* plant. The students had to observe, assess, and quantify one particular trait in generate one. Then they needed to attempt to change the genetic makeup of the next generation with respect to this trait, so that the next generation, on average, exhibits the trait to a substantially greater degree than the first generation. Student had to maintain scientific journals to document their data, results and process. The final for the fall semester was to create a scientific report of their Fast Plant artificial selection experiments using data, results and photos they had collected throughout the semester. Students also needed to complete a reflection for this experiment. The reflection asked students to think critically about how their journals helped or hindered their ability to answer their original scientific question for the Fast Plant artificial selection lab. Students had to show off examples of what worked and didn't work during their fall 2016 study and propose changes for a new Fast Plant study based on what worked and what didn't work in the fall study.

As shown by examples of student reflection below, asking students to take responsibility for analyzing, reflecting and thinking critically about their own work turned out to be a powerful experience. Students were able to identify areas to improve. Moreover, students had experience with the entire process and after trying to analyze and interpret their results from their fall experiments they had new insights with respect to what kind of data would have been most helpful as they try to make strong conclusions or interpretations regarding their study. It was also empowering to have students propose changes to how they should use their notebook for a new Fast Plant study. They were excited to throw out new ideas for data collection and methodology that could build upon their successes and failures from the fall. They also had to propose a new experimental study for the spring semester. Students were very invested in their proposed designs and were able to share these with the class at the start of the second semester.

Results

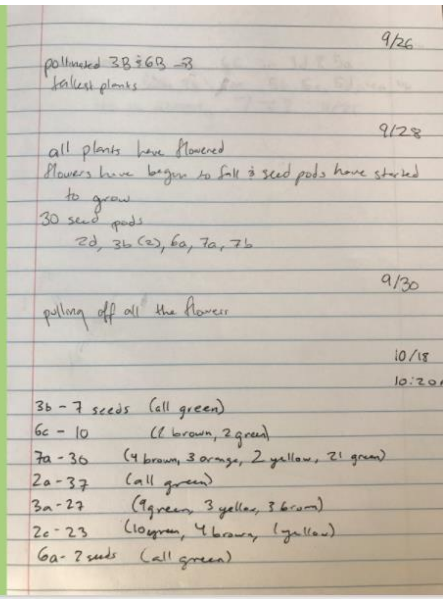


Because we had limited data, we were only able to create one graph comparing the tallest plant heights of the parent generation and the filial 1 generation.

In 2017, students should have ample data to create several graphs and tables displaying plant pigment both within each generation and across each generation.

Methods (cont.)

Unlike our previous experiment, whose data recording was not as extensive as would have been helpful. As you can see, keeping track of the seeds was not put in an actual data table. These details could have helped quantify information surrounding the zygote of the fast plants.



2016 Study- Problems

Methodological problems previously faced:

- Insufficient and relatively inaccurate data was recorded about the hairiness of each plant. It was very hard to get a good count of the hairs because they would fall off overtime and were very hard to see.
- Not enough data was taken over the course of the semester due to a lack of planning and tables to record our data
- There was an insufficient amount of seeds to begin with which limited the amount of plants in the F1 generation to use.
- We did not use the color scale until after the second generation was planted so we had to rely on the pictures of our first generation to compare our results.
- The dates weren't written down regularly, instead I wrote what day of the process it was which made it hard to figure out at what point in the process our observations were taken.

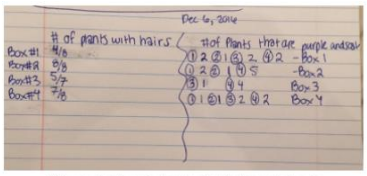
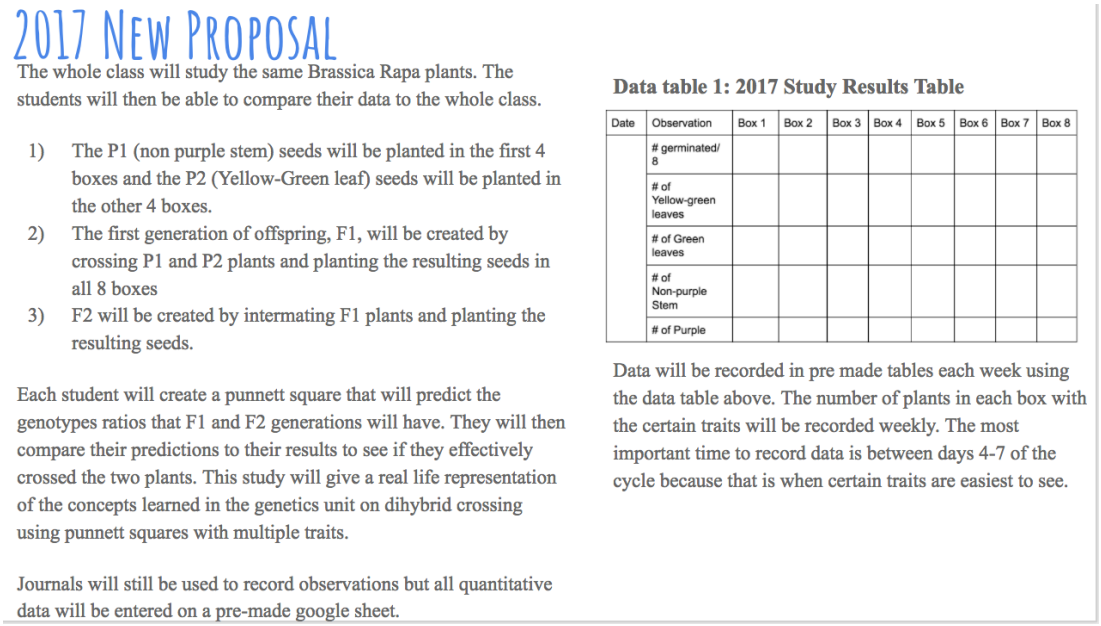


Figure 3: Purple index table in notebook

Results were recorded in an unorganized way- not all plants were recorded in the first generation only the three hairiest were.



Figure 4: Number of hairs per box table in notebook



2017 New Proposal

The whole class will study the same Brassica Rapa plants. The students will then be able to compare their data to the whole class.

1) The P1 (non purple stem) seeds will be planted in the first 4 boxes and the P2 (Yellow-Green leaf) seeds will be planted in the other 4 boxes.
2) The first generation of offspring, F1, will be created by crossing P1 and P2 plants and planting the resulting seeds in all 8 boxes
3) F2 will be created by intermating F1 plants and planting the resulting seeds.

Each student will create a punnett square that will predict the genotypes ratios that F1 and F2 generations will have. They will then compare their predictions to their results to see if they effectively crossed the two plants. This study will give a real life representation of the concepts learned in the genetics unit on dihybrid crossing using punnett squares with multiple traits.

Journals will still be used to record observations but all quantitative data will be entered on a pre-made google sheet.

Data table 1: 2017 Study Results Table

Date	Observation	Box 1	Box 2	Box 3	Box 4	Box 5	Box 6	Box 7	Box 8
	# germinated/ 8								
	# of Yellow-green leaves								
	# of Green leaves								
	# of Non-purple Stem								
	# of Purple								

Data will be recorded in pre made tables each week using the data table above. The number of plants in each box with the certain traits will be recorded weekly. The most important time to record data is between days 4-7 of the cycle because that is when certain traits are easiest to see.

Second semester, each class ran a class Fast Plant study versus small group experiments. The classes collectively voted on having 1 big experiment in order to capitalize on the opportunity to collect more data. They thought having more people working on the same experiment would help ensure better data collection; if someone missed an observation another person in class would be able to collect the same data since everyone was working with the same plants. One class designed an experiment testing the ideal fertilizer level; 0 vs 3 to 4 pellets vs 10 pellets. The second class designed an experiment to test what effect gibberellic acid (a plant growth hormone) would have on standard and dwarf Fast Plants. One major component of both of these experiments was to provide students with the opportunity to redo an experiment and learn from the first trial. Moreover, students were strongly encouraged to work together to collect strong data throughout the study.

Across the board, the second semester Fast Plant experiments were stronger; data collection, analysis, scientific write up and interpretations! As demonstrated by student reflection (see examples below) after this project, students felt more confident working with Fast Plants a second time. Moreover, their careful and thoughtful data collection second semester paid off and they had strong data to help them demonstrate their findings. Students also really saw that having the opportunity to redo an experiment was more akin to what scientists do regularly. I think by having the opportunity to rerun this experiment students were taking part in the process of science. In the past, I have never taken this much time to redo such a longitudinal study. However, based on this experience this year, I will look for ways to consistently have students engage regularly in reworking their experiments. Learning from your mistakes is such a powerful process. We had the opportunity to immediately follow up and redo a longitudinal study and learn from not only individual mistakes and individual successes but the entire class

was able to share their experiences with one another. This process was a great example of an activity that enables both individual and class success.

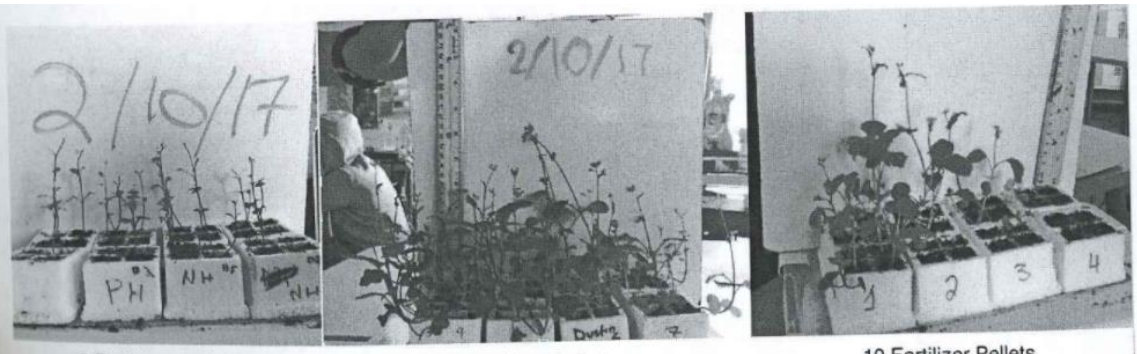
Fertilizer Artifacts

Reflection:

After completing a second experiment with Fast Plants I have learned the value of taking thorough and consistent data. In our first experiment, we only took the bare minimum amount of data we thought we needed to support our point but in our second experiment because at first we did not know specifically what to work for and we took a wider range of data. By doing so we had more overwhelming evidence to support our hypothesis than if we had focused on just one feature like before. I also gained a deeper understanding of how to work in groups because I had never worked in that big of a group before on a project for science. It taught me how clear communication and organized expectations are vital for the success of the experiment because at the end if everything is not formated the same way it makes it very difficult to draw one cohesive conclusion. Science is not only about curiosity and exploration but also about collaboration and organization.

5/5

Nice



0 Fertilizer Pellets 3-4 Fertilizer Pellets 10 Fertilizer Pellets

Figure 1: Pictures of Each Fast plant on February 10, 2017

Data Collection Dates

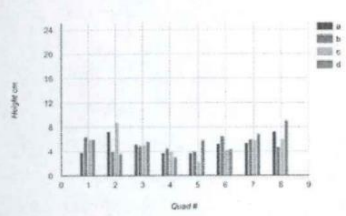
Table 1: Corresponds to Graph 2. This table gives the data for each group's tallest plants overtime.

Average Tallest	1/27/17	1/31/17	2/2/17	2/6/17	2/10/17	2/16/17
0 Pellets	1.2875	3.3	3.9125	5.4625	7.9625	10.2
3-4 pellets	2.5125	5.3	5.8375	9.525	16.4	22.2375
10 Pellets	0.7	2.0375	2.125	3.025	5.15	9

Table 2: Corresponds to Graph 1. This table gives the data for each group's tallest plants overtime.

Average Shortes	1/27/17	1/31/17	2/2/17	2/6/17	2/10/17	2/16/17
0 Pellets	0.6625	2.125	2.35	3.375	5.0375	5.5
3-4 pellets	0.6875	3.375	3.4625	4.2	8.05	10.1875
10 Pellets	0.225	1.1	1.225	1.5625	1.8875	2.0375

Gibberellic acid Artifacts



good structure side by side

Figure 4: Average Height of Rosette Fast Plants with Gibberellic Acid (2/10/17)

This graph illustrates the average height, measured in cm, within each of the quadrants of the 8 main quads. The quadrants are labeled a, b, c, d, respectively.



Figure 6: Photograph of Rosette Fast Plants with Gibberellic Acid (2/10/17)

This figure is a photographic representation of the height of the Rosette Fast Plants with Gibberellic Acid on February 10, 2017. This a side-view photograph.

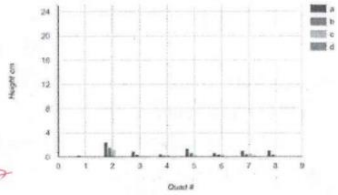


Figure 5: Average Height of Rosette Fast Plants without Gibberellic Acid (2/10/17)

This graph illustrates the average height, measured in cm, within each of the quadrants of the 8 main quads. The quadrants are labeled a, b, c, d, respectively.



Figure 7: Photograph of Rosette Fast Plants without Gibberellic Acid (2/10/17)

This figure is a photographic representation of the height of the Rosette Fast Plants without Gibberellic Acid on February 10, 2017. This a side-view photograph.

nice side by side

Reflection:

After completing the second round of the Fast Plant Experiment, I learned the importance of organized data collection. With our initial experiment, I was messy and did not keep my data in uniformed tables or spreadsheets. When it came time to put together my findings, the data I collected was unorganized and uniform. Because of this, I struggled to find trends amongst my data and it was not supportive of my hypothesis or the question that I was trying to answer. Given this set back, collecting appropriate and organized data was most important to me. I wanted to make sure that when the class eventually reconvened to write a discussion, there would be an appropriate amount of organized data that could support or refute a hypothesis. I wanted to make sure that my contribution to the class was constructive and could be used and understood accurately.

By re-doing this experiment, I realize that in science you cannot always be satisfied with one trial or test. In order to really understand an experiment you must test it hundreds of times and not be discouraged if your data is inconclusive. But rather, it is important to learn from your mistakes and further refine experiments so that the best data can be collected. With the initial

Harry Hobart

experiment I was unsure at times when to collected data or make observations, The second round helped me learn from my mistakes and become more confident with my scientific abilities. In the future I would have students work individually with both the initial and second experiment. I think that the group element can sometimes obstruct observational learning and I believe it might be interesting to see if better data is collected when students work alone and then eventually collaborate once the experimental process has concluded.

Reflection

Re-doing the Fast Plant experiments taught me the importance of cohesive and consistent data collection. The process of preforming the experiment was not personally particularly different from last semester. The differences arose when beginning to organize and analyze the data from the entire class. I felt fortunate to have such a wide breadth of data, both quantitative through height measurements and qualitative through photographs, although the inconsistencies made analysis particularly difficult. I felt as though I had to spend an unreasonable amount of time tracking down other groups data, uniformly formatting and filling in both personal gaps in data and others. I have gained a new appreciation for the intricacies of not only the process of science in terms of preforming experiments, but also of thorough and premeditated organization and clear communication. If this experiment were to be run again I would have the class clearly establish the kinds of data they wanted to collect, and the format they want to collect it in, and how they wanted to share it amongst the class. I would also have the class keep both digital and paper notebooks simultaneously to cut down organization time at the end of the experiment and to allow for more efficient collaboration. I think that by following this adjustments the process of analyzing this experiment would be both more enjoyable and efficient. 5/5

I learned better ways to take notes, and that as an entire class, we could have still been more united on this experiment. I think as a whole class, the notes and data were overall better, and the photos were an effective way to keep track of everything. However, as a class, the notes were slightly different, and we should have kept a standard for more uniformity. This would have been especially helpful with graphs when we started our discussion. But, as I said, the notes, on the whole, were far better than last semester's, and I believe that to be because of the practice that we had, and the amount of reflection that we did after the project was over.

I really enjoyed this process because we were not all responsible for different experiments, but only for a specific part. This helped me understand the importance of each piece of data, and I believe it to be why this experiment was so successful. Not only did we have a larger amount of data, but the data was cared for more intensely by each group. I would not change anything from the actual process, apart from more uniformity in the notes that were taken.

Experimental Design Teacher Reflection Fall 2016

Exploring Experimental Design was a new elective this year. I was nervous about teaching this inquiry based class because it was a new prep and course. The stakes were high because this course is associated with our new MARC (Marin Academy Research Collaborative) program and our new Science and Innovation building. The purpose of this semester elective is to provide an opportunity for students to explore their own interests in science through inquiry and experimentation. I designed the exploring experimental design course so that students had opportunities to design and study an area of content that interest them. Students proposed a 3 to 4 day investigation that includes a laboratory investigation and content that helped to support an inquiry project and their specific area of interest. This year's 2016 fall semester course covered a range of topics including forensics, bioengineering, phytoplankton, neurology, the endocrine system, fungi, engineering and an experimental design unit. Throughout the semester and mini units students used scientific journals to document their work, data and studies.

Students had a range of experiences with respect to using the journals. Some students wanted more guidelines. I asked students to use their journals for everything; note taking in class, recording data during labs, drawing and observations in the field and asking questions and exploring ideas. Some students wanted to only use their journals to record data in labs. They did not like using these journals for note taking during class. However, other students liked having all of the content in one place. They felt like they learned more and retained the information better because everything was in one place and they could apply content from class to lab techniques and data. Some students commented that just maintaining a journal throughout the semester made them "feel like a real scientist"!

As a teacher, I loved having students use the journals for everything in this course. This course is a low stakes, highly engaging inquiry based course. There are so many opportunities for students to try different things; field work, lab work, and modeling. I was able to see a wide variety of ways that students organize their thoughts, notes, data and ideas. At the end of the semester students were able to use these journals during their final lab practical. This was a great way to ensure that students regularly recorded notes in their journals. If I have the opportunity to teach EED again, I will definitely continue to ask students to maintain journals for this class. It's a great way for me to check in on how they are learning and practicing science and for students to practice science, observe and interpretation.

Teacher Reflection: How journals support the process of science

I am committed to using science notebooks (field journals/science journals) moving forward with my teaching. Science journals are an absolutely wonderful tool to see how students are learning, thinking and observing. These journals encourage students to become active agents in their own learning. Students can record questions that they have about content to these journals and be responsible for following up and learning more about these inquiries. Moreover they serve as a great template for students to practice accurate scientific observations.

I have also learned that science journals allow students to communicate information in multiple ways. Some students consistently illustrate their work with sketches and drawings. Other students like to write out their work. While others use tables and charts to organize their work. It has been great to ask students to share their journals with the class so they can learn how their peers communicate in different ways. Moreover, when I review student journals I can see how students are thinking, what students understand, what students have misconceptions about and how they are organizing information. All of these things can help me design lessons and activities to ensure students are growing as scientists and life long learners.

In my Exploring Experimental Design class I was able to see lots of different types of writing styles from students; writing procedures, descriptive writing, explanatory and interpretive writing. It is interesting to see how students can convey information more clearly when they are given multiple opportunities (sketch, use tables, write text) to explain themselves.

I have also learned so much more about my students and their interests across the board using journals and notebooks in class. For example, by reviewing the questions students are asking in their notebook, I can tap into their individual interests. I can also learn more about how each student learns and expresses themselves by regularly reviewing their work in these journals. Notebooks can also help students work at their own pace.

Finally, I feel like I am a better teacher/coach using notebooks regularly. I feel like I have more windows into students' science training by using notebooks. It is easy to fall into using summative assessments regularly to monitor progress however, the beauty of science journals and notebooks are that these assignments are low stake and great ways to assess learning in process (formative assessment). Reviewing student work in these journals is a great technique to monitor student learning and to identify areas where students are struggling, or succeeding and to learn more about what interests them.

PART 3: **Journaling relating to other Trans-Teachers Experience**

Before Trans Survey Reflection

I am really interested to find out if my experience as an online and face-to-face teacher are similar to other teachers who flow between face-to-face teaching and online

teaching. I have felt incredibly challenged creating an online blendEd course. I also feel like I have grown markedly as a teacher, colleague, professional during this experience.

I know that I have devoted an incredible amount of time to developing my online ecology course. I suspect this is a common experience among my peers who have developed online courses. Many programs, schools require that the entire course gets developed prior to students beginning the course. This takes an incredible amount of time and thoughtfulness. Moreover, the editing, reflection and innovation that consistently goes into tweaking the course seems to be greater than face-to-face course development. I am not sure if this is because there seems to be more variables or if the stakes just seem higher or what...but I am curious if my colleagues have also found this to be true. I remember one of my online teachers at MSU telling

There are a number of actions and practices I have executed and delivered in my face-to-face classroom since teaching online. For example, I have eliminated poorly designed lessons in my face-to-face classes. I have redesigned and added lessons in my face-to-face classroom to optimize the time I have with my students in person. I think my lessons are even more student focused in my face-to-face classes because I appreciate the time I have with the students in person. I feel like I challenge my face-to-face students more because I know what students can do independently due to my experience teaching online. Moreover, I consistently provide more timely feedback since teaching online. I feel compelled to give my online students swift feedback so that they are heard and can apply my feedback to their next assignments. I found myself sometimes neglecting this timely feedback in my face-to-face classes, prior to teaching online however, since teaching online I now adopt this same turnover rate to my face-to-face classes and the students have responded well. I also feel like I ask all of my students to reflect and think more about their learning process and consider how they are learning and growing. This type of reflection and practice I think I just took for granted when only teaching face-to-face. I think I just assumed students were learning. They were doing well on summative assessments and moving forward with projects. However, online learning really helped me drill down and try to understand how students learn. Online teaching encouraged me to help build in skills to develop critical thinking and lifelong learning into the curriculum as often as possible. Moreover, online learning encouraged me to be more empathetic and get to know all of my students better. For example, by incorporating science notebooks into all of my classrooms, I have a built in flexibility to allow students to communicate with me and their peers in multiple styles. The notebook allows students to explore ideas, questions and content in ways that a traditional assignment might not offer.

I certainly am more comfortable using technology in all of my teaching now, however, I have always been pretty courageous and open to new ways of doing things. I certainly have been able to use some of the discussion board assignments and citizen science apps in my face-to-face classes which benefits all.

I now use iNaturalist in three of my face-to-face classes; advanced biology, exploring experimental design and AP environmental science. Not only has iNaturalist been a convenient way to collect data in the field, it has also been a great way to monitor change over time in our school campus and in our local parks. Although, I don't use iNaturalist as regularly in my face-to-face classes as I do with my online ecology class, I use it enough so that students have the opportunity to get hooked on the app and use it for fun if their interest is tapped.

I don't think I would have explored citizen science projects as rigorously prior to teaching online. The collaborative nature of many citizen science projects with peers, community members and experts has always been appealing to me. Moreover, collaboration has been something I wanted to work harder at establishing in my online course because I could not directly facilitate it as I would in a traditional classroom. Mary Ellen Hannibal, talks about citizen science as being a platform for change and an opportunity to see without the old blinders in her book, "Citizen Scientist". Citizen science allows amateurs and naturalists to join forces and help promote biodiversity and respond to extinction and invasive species migration. It has been exciting to participate in projects with students that demonstrate how science is changing. Science is much more collaborative and transparent right now in light of crowd-sourcing data collecting tools like iNaturalist. Moreover, the opportunity to empower students to participate regularly in data collection and connect with nature have been especially transformative and joyful for me as a teacher. It is fun to see students engage with things they are comfortable with already (phone apps) and use this (app) as a tool to learn more about their communities and our earth.

I certainly think I communicate more effectively with all of my students due to my foray into online teaching. Online teaching requires more detailed explanation. I feel like I am more specific in my assignments across the board with my face-to-face students and my online students. Teaching at a distance, I found that sometimes even simple directions can seem overwhelming to students. I have learned to explain concepts more clearly and provide more examples to demonstrate expectations.

Another area that I have grown in is my empathy in terms of deadlines for assignments. Often with my online class, I may have flexible deadlines built into assignments. Assignments are launched every week and due within a two week period. Students can work at their own pace and have a range of days when they can turn an assignment in. Traditionally, in my face-to-face classes I have had one deadline that is not negotiable. However, I have found myself using backward design more for projects and offering students more options for submitting work in my face-to-face classes. I will sometimes provide an incentive if they meet with peers to review their work in tutorial or meet with me during tutorial to review work. If they take the time to pursue careful peer review they can get a one day extension. Some students have done this. I never would have done this prior to teaching online.

I think one of the biggest outcomes of teaching online for me as a professional educator has been the opportunity to reflect on my practice. I can relate to educational philospoher Maxine Greene a bit more now after teaching online and reflecting on my own practice of teaching. Maxine Greene said:

> Education, at its best, is a process of teaching people to explore ideas about themselves and the world in which we live, to ask questions about this experience called living, to embrace ambiguity, to notice the unusual without fear, and to look upon the ordinary with new eyes.

I think developing an online ecology class and reflecting on the process over the last three years through this master's program has helped me to try new strategies, learn from my reflections, and engage rigorously with continuous growth as a teacher, citizen and student.

After Trans Survey Reflection

One of the things I was most interested to find out from my colleagues who also teach both face-to-face and online, was, "overall do you think teaching online has had a positive impact on your face-to-face teaching?". The majority of participants in the survey (22/25) replied somewhat or very much to this question. Interestingly 70% of the GOA teacher replied very much whereas in our blendEd consortium opinions were much more varied. I suspect this has to do somewhat with overall online teaching experience. The blendEd online teachers have between 1 and 3 years of online teaching experience whereas the GOA teachers on average have more experience.

Across the board there were many challenges common to all teachers. BlendEd teachers mentioned the following, **"Communicating clearly online.**", "Adjusting to the much different vibe of a virtual class meeting, ", "Trying to do too much. **Not understanding the limitations of time.", "The amount of time it took to design a new course in a new medium**", Fluidity of concept development. Determine how to guide the students along a path to understanding without smothering them or losing them. ", "Students fell behind in the work, since there was less face-to-face contact and thus it was easier for students to skirt or shirk responsibility around work completion.".

GOA had some challenges that were unique to this program, like "connecting with students across the world in a regular and meaningful way." GOA teachers also agreed that time management was a big challenge. **"Management of time when designing and facilitating simultaneously.**", **"My own time management",** "A terrific amount of time that I was not expecting. Very very time consuming." "Creating time to get to know my online students while not neglecting my face-to-face class.". One GOA teacher mentioned, "Planning, you must have the course done ahead of the students arriving to it. Some reactive planning can happen but this means you are interacting, grading and designing. This can make things stressful."

BlendEd teachers reported the following successes with respect to their online classes and course development, "Getting kids outside to do applied work because we could use the internet as the "classroom". **Fun to experiment with more innovative class"**, "I had great 1-1 online tutorial sessions with students and found that it was just as easy to guide

them to breakthroughs/a-ha moments virtually than in person", "Rich projects from students", "Connecting with students in different ways", "Lots of smiles, so something must be working. I enjoyed the online one-to-one conversations.", "Connecting with experts, both virtually and in person", and **"Online discussions felt rich and vibrant, much more so than I expected. The students did a lot of work- I don't think that the output was that different from my other classes, though the work was spaced out differently.** Field trips: though I still don't understand what students took from them, and the fact that they were built into the nature of the class. This was pretty rewarding to see students out in the wild."

GOA teachers reported the following successes, "**Giving more autonomy to students to demonstrate their learning and encouraging students to curate conten**t. **This inspired me to transfer this autonomy and personalization into my face-to-face classes by creating assignments that were more flexible and open ended.**", "How much the online class still builds community. Ability to generate amazing peer feedback opportunities", "The level of engagement and investment is/was amazing.", "Kids will have the same kind of relationship with me in a classroom as they do online. **The things that work to build relationships in a class are similar to those in an online classroom.**", "A lot of the students love the course and move forward with the topic.", **"Seeing students really engage. I find them to be more open, less judgemental than face-to-face students, both towards each other and towards me.",** "**The same as in a face-to-face class--seeing students following an interest and learning from their choices.",** "Incredible connections with motivated and sharp kids. They are in my course because they really want the experience and are incredibly talented and gifted.", **Improving my teaching in both mediums".** My online class inspired me to take risks and ask students to take on large scale projects I had never implemented before.

With respect to how colleagues have grown professionally by developing and teaching an online course, my BlendEd colleagues had the following things to say, "Yes, online teaching has inspired me to do more applied/field work with students.", **"I've come to think much more deeply about design and user (student) experience of all little and big details related to my course. This work also keeps me firmly rooted in a growth-mindset as I am continually honing my course.", "Yes, I have fallen in love with creating courses that step outside of the norm.",** I feel like I make better use of classroom time and that I am more likely to make directions very explicit. I also feel more comfortable flipping the classroom", **"I have brought better communication skills to my classes"**, "I'm a lot more adept at making effective screencast/flipped teaching videos. **"I reflect so much more on my teaching practices and I use these reflections to help me make changes that will impact my students growth and learning."**

GOA teachers said with respect to professional growth, "I am much better at understanding backward design and scaffolding", "I think I am beginning to pay much closer attention to the intentional design of my classes", "**It has made me a more**

organized planner. I am able to use my planning time more effectively. ", "Reinvention", "It has put me in touch with a dynamic group of colleagues who don't fear or resist change. It has helped me learn how to use new tech tools. It has helped me reconsider every aspect of teaching: how to form relationships with students, how to cultivate their curiosity, what degree of accountability is reasonable...also how to define when/what I'm teaching", "Massive growth. **I'm reflecting on practice. I"m refining how I structure communication, participation, and interaction, etc.**", "More connected to other like-minded instructors. **Better at reflecting on my own teaching**. Better able to communicate with face-to-face faculty about the possibilities of connections while teaching online."**, Yes, I have gained an appreciation and an excitement for online teaching."**

APPENDIX F

GALL LESSON PLAN

Lesson Objective: Introduce gall ecology to online ecology and advanced biology students

Key Knowledge and Skills: Identify galls in the environment, Understand plant hormones, tumors, evolution, coevolution, gall insects, and changes in gall ecology over time.

Lesson Structure:

- All students take pretest on gall ecology
- All students review a PPT independently (at home) on Gall Ecology.
- All students review a teacher screencast video (HERE) independent (at home) on Gall ecology.
- All students have physical galls to observe, illustrate and journal about in their science notebooks.
- All students participate in an in class assessment on gall ecology.
    - Teacher uses Peardeck to check in on student understanding of gall ecology.
        - Students can answer questions independently and in pairs to show off their understanding.
    - Colleague will observe this assessment lesson using a formal observation instrument.
- After the in class assessment activity all students will take the posttest on gall ecology.

APPENDIX G

FORMAL OBSERVATION INSTRUMENT

Gall Assessment (Part 1)

Observation Date: 11/17/16	Time: Start 9:20
Evaluating Teacher: Ellie Beyers	Time: End 10:35

Part 1: The Lesson
Section A: Basic Description Information

1. Teacher: Liz G

2. Course Observed:

3. Grade Level(s): 11/12

4. Students: 4 Number of Males 6 Number of Females

What is the purpose of the Observation instrument?

- How am I doing guiding, facilitating, monitoring, adjusting and adapting to learning status in my classes?
- How am I creating a learning environment in both the nontreatment group (Advanced Biology) and the treatment group (BlendEd Ecology)?
- Go over the 5 attributes that the observer will evaluate using the Observation Instrument; Learning targets, Monitoring tasks that elicit evidence of learning, Feedback that moves learners forward, Self Assessment that shows students as owners of their own learning and Peer Assessment that demonstrates students as instructional resources for one another.

Table 1: Formative Assessment Observation Instrument

A. Learning Targets: *Clarifying Learning Intentions and Sharing Criteria for Success*					
Does the teacher make certain that students understand the learning intentions for the class session?	1	2	3 ✓	4	5
Does the teacher make certain that students understand the learning intentions for each activity			✓		
Does the teacher provide examples of high and low quality work? N/A					
Does the teacher address potential misunderstandings regarding the criteria for success? N/A.					
Why did you answer this way? Are there any additional comments? Overview of topics at start of class					

B. Monitoring: *Engineering Effective Classroom Discussions, Questions, and Learning Tasks that Elicit Evidence of Learning*					
Does the teacher make efforts to monitor student learning on an ongoing basis (i.e., minute-to-minute & day-to-day)?	1	2	3	4 ✓	5
Does the teacher give students a variety of opportunities and methods (e.g., verbal, written, electronic, & visual) to respond to questions?					✓
Does the teacher use effective questioning strategies (e.g., adequate wait time, open-ended questions) to elicit evidence of learning?				✓	
Does teacher monitoring seek to elicit evidence from students of both factual/procedural knowledge and of deeper conceptual knowledge?					✓
Does teacher monitoring seek to elicit evidence of whether students can transfer knowledge within and between disciplines/subjects? N/A					
Why did you answer this way? Are there any additional comments? Calling on Felix v not competing for same food sources Any questions? On occasions wait time short					

C. Feedback: *Providing Feedback That Moves Learners Forward*					
Does the teacher provide meaningful feedback (i.e., information with which a learner can confirm, add to, overwrite, tune, or restructure understanding) immediately following formal and/or informal evaluations of student progress?	1	2	3	4 ✓	5
Does the teacher provide accurate feedback that assists learning?					✓
Does feedback describe specific areas of needed improvement and suggest alternative strategies for making that improvement? N/A					
Does feedback describe specific student strengths and suggest strategies for continued learning in those areas? N/A					
Why did you answer this way? Are there any additional comments? Hints: sharing dessert. Giving more detail on student answers Tips: think of one for genetics, evolution... feedback on answers to questions... e.g. epigenetics & goals..					

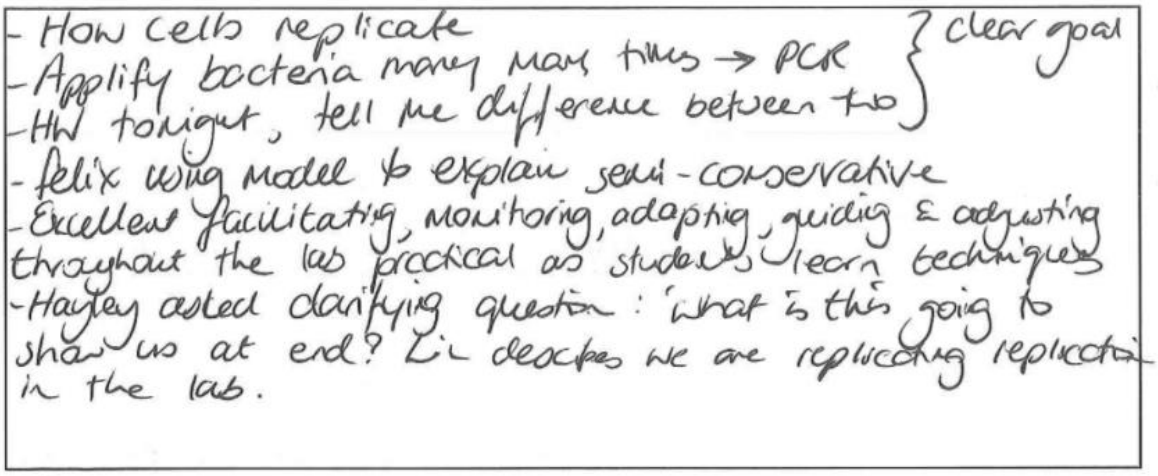


Table 2: Formative Assessment Observation Protocol

Formative Assessment Observation Protocol

A) Learning Targets: Clarifying Learning Intentions and Sharing Criteria for Success

1) Does the teacher make certain that students understand the learning intentions for the class session?		
Scale	**Attribute**	**Description**
1	N - No evidence of use	Teacher does not mention learning targets (e.g., objectives, goals) for the class session.
2	N – Superficial or ineffective use	Teacher may post and/or state learning targets , but there is no explanation of what students will need to know
3	N/A - Minimal use or uncertain effectiveness	Teacher describes learning targets (i.e., a specific description of the learning goal being aimed for during the session) adequately in such a way that students can have a clear, solid vision of the learning targets they are responsible for achieving.
4	Y - Frequent Use or Effective	Teacher both describes learning targets and makes clear attempts to evaluate student understanding of those learning targets.
5	Y - Pervasive Use or Highly Effective	Throughout the session, teacher continually reminds class of learning targets, seeks to gauge understanding of those targets, and seeks to evaluate whether students understand them in light of classroom activities.

2) Does the teacher make certain that students understand the learning intentions for each activity?		
Scale	**Attribute**	**Description**
1	N - No evidence of use	Before activities during the class, teacher does not communicate the learning purpose or criteria of learning success for that activity.
2	N – Superficial or ineffective use	Before activities, the teacher may mention a learning purpose for the activity, but there is no explanation other than procedural directions.
3	N/A - Minimal use or uncertain effectiveness	Teacher describes learning targets (i.e., a specific description of the learning goal being aimed for during the activity) adequately in such a way that students can have a clear, solid vision of the learning targets they are responsible for achieving in that activity.
4	Y - Frequent Use or Effective	Before each activity, the teacher both describes learning targets for the activity and makes clear attempts to evaluate student understanding of those learning targets for the activity.
5	Y - Pervasive Use or Highly Effective	Throughout each activity, the teacher continually reminds students of learning targets, seeks to gauge understanding of those targets, and seeks to evaluate whether students understand them in light of the learning intentions for the class session.

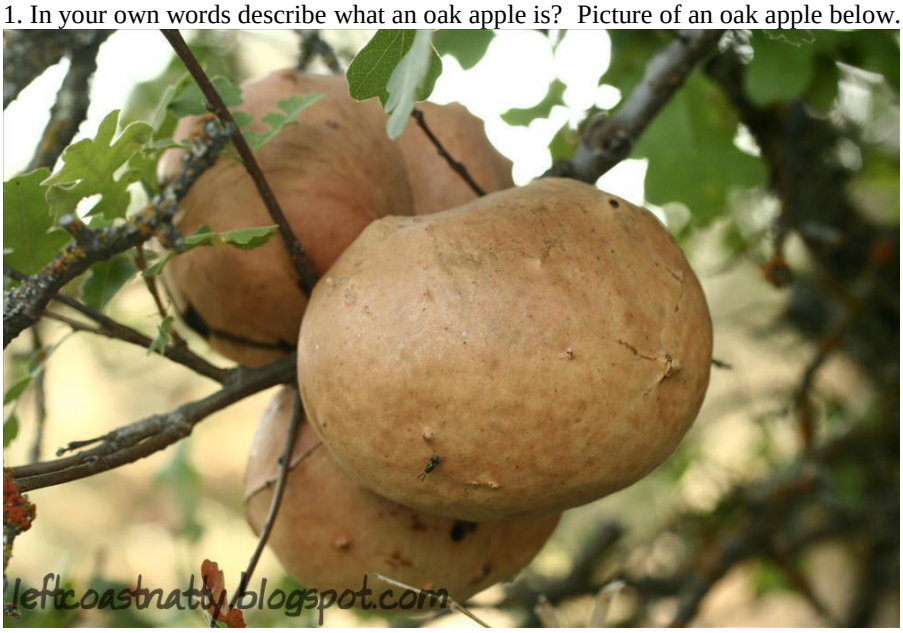
3) Does the teacher provide examples of high and low quality work?		
Scale	**Attribute**	**Description**
1	N - No evidence of use	Teacher does not provide examples of high or low quality work for the class session or class activities.
2	N – Superficial or ineffective use	Teacher may provide one or two examples of high or low quality work, but with little or no explanation by teacher.
3	N/A - Minimal use or uncertain effectiveness	Teacher may provide one or more examples or high or low quality work, providing explanations regarding the quality. Teacher does not include examples of both low and high quality work. Teacher may provide examples before or during class and/or activities.
4	Y - Frequent Use or Effective	Before the class session and/or individual activities, the teacher provides examples of both high and low quality work, explaining why they are different in quality.
5	Y - Pervasive Use or Highly Effective	Both before and during the class session and/or individual activities, the teacher provides examples of both high and low quality work, comparing and contrasting the reasons that they are different, and evaluating student understanding of those differences.

1) Does the teacher address potential misunderstandings regarding the criteria for success?		
Scale	**Attribute**	**Description**
1	N - No evidence of use	The teacher does not address any potential misunderstandings regarding the criteria for success.
2	N – Superficial or ineffective use	Before the class session and/or learning activities, the teacher may mention one or two potential misunderstandings, but the teacher does not explain why they might exist.
3	N/A - Minimal use or uncertain effectiveness	Before the class session and/or learning activities, the teacher describes potential misunderstandings and explains why they might exist on a factual/procedural basis.
4	Y - Frequent Use or Effective	Before the class session and/or learning activities, the teacher describes potential misunderstandings and explains why they might exist both on a factual/procedural basis and on a deeper conceptual basis.
5	Y - Pervasive Use or Highly Effective	Throughout the session and each activity, the teacher makes certain that students understand potential misunderstandings regarding criteria for success and the reasons such misunderstanding might exist.

APPENDIX H

PRE AND POSTTEST GALL ECOLOGY

1. In your own words describe what an oak apple is? Picture of an oak apple below.



2. In your own words describe what a tumor is below.

3. Which one of the following is NOT a plant growth hormone?

a. Auxin
b. Cytokinin
c. Insulin
d. Ethylene

4. What is the main function of a plant hormone?

5. Name one example of how plants and animals have coevolved?

6. All of the structures protruding out of each leaf pictured in the table below are called? (Name one word to describe these structures.) Are these structures harming the plant in any way? Y/N







7. What is the difference between a generalist species and a specialist species in ecology?

8. What type of insects typically lay their eggs on tree bark, leaves or tissues?

9. Why do insect populations vary in size from year to year?

10. The study of cecidology is
    a. The study of insects
    b. The study of dendrons and their characteristics
    c. The study of galls and the insects that induce them

11. How can the study and interpretation of individual trees inform us about the environmental conditions of one's ecosystem?

12. Which number (category below) represents how likely you are currently to carefully study trees and their component parts (leaves, trunks, branches) in your environment.
    1. Very unlikely
    2. Unlikely
    3. Neither likely nor unlikely
    4. Likely
    5. Very likely

Post Gall Advanced Biology

1. Please describe your experience with the gall lesson. What did you like? What did you dislike? How was the blendEd (online and Face-to-Face) components? Did teacher enthusiasm or lack of enthusiasm help or hinder the experience? How does this compare to other educational science experiences you have had?

2. After participating in this lesson are you interested in online or blendEd learning or courses?
Yes
No
Maybe

APPENDIX I

TRANS-CLASSROOM TEACHER SURVEY

Purpose: The objective of this study is to examine how online teaching impacts classroom (face-to-face) change.

1. What is your subject area (online)?
a. Social Sciences
b. Science
c. Computer Science/Programming
d. Math
e. Arts/Art History
f. Foreign Language
g. Other

2. What is your subject area (face-to-face)?
a. Social Sciences
b. Science
c. Computer Science/Programming
d. Math
e. Arts/Art History
f. Foreign Language
g. Other

3. For your first blendEd course did you
a. Adopt an existing online course
b. Develop a course never taught
c. Adapt a course current teaching face-to-face
d. Adapt a course had taught face-to-face in past

4. How often did you do the following in your online course?
At least occasionally OR Never
a. Have students complete multi-week projects
b. Have students work collaboratively in groups
c. Have students do peer reviews
d. Have students create multimedia assignments

5. Do you also teach face-to-face?
a. Yes, but difference courses
b. Yes, similar courses
c. Yes, the same course
d. No

5. Overall, do you feel that teaching online has a positive impact on your face-to-face teaching?
a. Very much
b. Somewhat
c. Neutral
d. Not very much
e. Not at all

6. If you also teach a face-to-face course, please review the following changes to your face-to-face course that you have experienced since teaching and designing an online blendEd course.

Changes	Likert scale Rating No change Major

	changes 1 2 3 4 5
Course design/redesign Eliminated lessons that now seemed poorly designed	
Redesigned lessons using Backward Design principles	
Designed new lessons using Backward Design principles	
Added lessons/units that had been successful in online course	
Course organization Did more advance planning	
Used class time more efficiently	
Changed how groups were organized	
Broke projects into smaller pieces (chunking)	
Provided additional scaffolding for large projects	
Communication (teacher-to-student, student-to student) Made instructions clearer/more explicit	
Made key concepts clearer/more explicit	
Provided more detailed instructions	
Provided more written instructions	
Provided additional means for students to communicate with me	
Used an online discussion forum in my classes	
Provided more timely feedback	
Required class contributions from all students	
Found ways to give students more time to formulate answers	
Found additional ways to monitor individual students	

Changes	Likert scale Rating No change Major changes 1 2 3 4 5
Assignments/assessments Added written assignments	

Made written assignments longer	
Added communication projects (i.e., student-to-student, student-to-expert, via email or videoconferencing)	
Added multimedia assignments	
Added peer reviews	
Added online tests/quizzes	
Reduced use of tests/quizzes	
Added new rubrics	
Refined existing rubrics	
Readings/resources Added more internet resources	
Assigned more internet research	
Assigned more internet-based activities (i.e., web-based simulations, WebQuests,)	
Assigned more current-events resources	
Assigned more real-time data sources (i.e., for science)	
Reduced reliance on textbook	
Added use of online survey tools	
Multimedia (as teacher and with students) Developed website(s) for my course(s)	
Encouraged web pages from students	
Encouraged other multimedia assignments	
Integrated new technology into lesson plans	

7. Comparing your online with your face-to-face students, which group

	Face-to-Face students	**No difference**	**Online students**
Is better prepared			
Works harder			
Is better organized			
Knows you better			

Do you feel you know better academically			
Do you feel you know better personally			

Open Ended Questions

8. Does your online course capitalize on having students in different physical locations? If so, how?

Class participation:
9. Have you been able to translate the participation that can be mandated in an online classroom (for instance, by requiring all students to contribute to a discussion forum) back to the classroom? If so, how did you accomplish this?

Independent learning:
10. Have you been able to translate the independent learning/responsibility for learning/independence of your online students back into the classroom? If so, how did you accomplish this?

Questioning techniques:
11. Have your facilitation or questioning techniques changed as a result of your experience teaching online? If so, how did they change and what effect do you think this has had on your students?

Metacognition/reflection:
12. Have you been able to translate the time for thought/reflection that is one outcome of the asynchronous nature of the online classroom back to the face-to-face classroom? If so, how did you accomplish this?

Personal growth:
13. What were the major challenges you faced the first year teaching your online course?

14. What were the major successes you discovered teaching your online course?

15. How have you grown professionally by developing and teaching an online course?

APPENDIX J

EXEMPTION MSU INSTITUTIONAL REVIEW BOARD

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Elizabeth Gottlieb and Walt Woolbaugh
FROM: Mark Quinn Mark Quinn CQ
DATE: November 1, 2016
SUBJECT: *"The Influence of Online Teaching" [EG110116-EX]*

The above research, described in your submission of November 1, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

__X__ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

__X__ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement}, survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.