Development and Implementation of a Problem Based Learning Project for PLPPM 3010 Biology and Management of Plant Diseases

INSTRUCTOR AND TEACHING STAFF

Kerik Cox, Associate Professor, Course Instructor, Section of Plant Pathology and Plant-Microbe Biology
Mary McKellar, Teaching Support Specialist, Section of Plant Pathology and Plant-Microbe Biology

This is a proposal for the development and implementation of a problem based learning project for the course PLPPM 3010 Biology and Management of Plant Diseases.

The course instructor, Dr. Kerik Cox, associate professor in Plant Pathology and Plant-Microbe Biology (PPPMB) and Mary McKellar, teaching support specialist in the School of Integrative Plant Science will work closely together to support, design and develop instructional materials for the project.

IMPACT

PLPPM 3010 Biology and Management of Plant Disease is a required course for the Plant Science major in the concentration of Plant Pathology as well as for the Fungal Biology minor. It is an elected requirement for the Plant Breeding and Genetics and Sustainable Plant Production concentrations for the Plant Science major as well as the Crop Management minor. The course is a pre-requisite for graduate students in the field of PPPMB.

Students in PLPPM 3010 are predominantly junior and senior level undergraduates and graduate students in PPPMB and plant breeding and genetics. Expected student enrollment is at maximum capacity for the course (40 students).

SUMMARY OF CHALLENGES

PLPPM 3010 Biology and Management of Plant Pathogens is a full semester four credit course consisting of three 50-minute lectures and one 3-hour lab section a week. Current learning outcomes for PLPPM 3010 include:

> **Outcome 1**: Students will be able to examine the concept of disease in the context of natural and agriculturally relevant plant systems.
>
> **Outcome 2**: Students will be able to demonstrate a good working knowledge of the biology of key plant pathogen groups: viruses, bacteria, nematodes, fungi, stramenopiles, and plants.
>
> **Outcome 3**: Students will be able to recognize the basics of plant disease diagnostics and integrated approaches to plant disease management.

Student centered learning strategies were implemented in the fall of 2017 to enhance the lecture including real-time in-class formative assessments of previous or gained knowledge as well as peer teaching. Laboratory activities focused on building a series of traditional microbiological skills through inquiry-based activities focusing on each plant pathogen group. Students then applied lab skills acquired over the semester to a final semester project centered on diagnosing unknown plant diseases.

Student feedback through course evaluations for PLPPM 3010 has been a valuable tool to assess the effectiveness of currently used teaching methods, content presented and laboratory activities. Several

course needs emerged from student feedback on course evaluations over the last five years. Specifically, these include:

- Authentic fieldwork in observing and collecting plant diseases in the field for further diagnostics in the laboratory.
- Understand how to apply disease management strategies using an integrated approach with consideration of growers, crop production, pathogen biology, and the environment.

The growing season in our area can restrict our ability to fully meet the first need above during the academic year and for this reason, our efforts to date have been to take a field trip to tour local fields and orchards during the first week of the semester. The course instructor and teaching staff pre-scout the site for plant diseases, and then during the field trip, the students receive a plant disease guided tour. The goal of the field trip is to provide students an opportunity to observe plant diseases in a natural setting vs. observing artificially inoculated plants in a lab setting. Despite the incorporation of the field trip, student feedback from course evaluations indicates that the method of content delivery could involve a more student-centered learning approach. Instead of a more passive learning role, students would like to take charge of finding and identifying plant problems on their own.

In addition to content knowledge outcomes for this course, we would also like to develop learning outcomes that target soft skills such as communication and self-directed learning. Results of a recent survey of plant science industry employers demonstrated that one of the greatest areas of deficiencies identified in new hires are non-discipline specific soft skills (Spakes-Richter et al., 2018). Deficiencies in both communication (oral and written) and time/task/project management were cited the most in this survey. In response to better prepare students for the workforce, we would like to add two additional learning course outcomes:

Outcome 4: Students will be able to demonstrate effective oral and written communications appropriate for specific stakeholder groups.

Outcome 5: Students will be able to demonstrate proficient self-regulated learning skills in relation to the development and management of a project.

RATIONALE

We would like to develop and implement a semester-long, problem-based learning (PBL) project to address the challenges not currently met by the course. Working with local stakeholders, student teams would be tasked with assessing local vineyards, orchards, vegetable and other specialty crops for fungal, bacterial, and virus diseases. Over the course of the semester, student teams will design guidelines for collecting disease samples, assessing field conditions, and diagnosing plant diseases. The outcome of this PBL will be to create a report for the grower on integrated pest management recommendations based on their compiled results. Students will work on the PBL project during and outside of scheduled class times. Inquiry based lab and some lecture activities will provide further content to support the PBL project.

PBL's are a student-centered learning strategy in which student groups work on a real-world task or problem to construct a solution. Based on the educational theory of social constructivism, students work collaboratively to make meaning of information resulting in greater conceptual understanding of the material (Eberlin et al., 2008). In addition, PBL fosters development of critical thinking skills important to

scientific inquiry by asking questions and actively seeking knowledge through collaboration with others (Eberlin et al., 2008). The benefits of PBL to student learning could increase achievement in meeting the first three course outcomes as outlined above. The field of plant pathology draws from many disciplines including mycology, microbiology, virology and plant science to name a few. Often, student background knowledge in some or all of these disciplines is limited. This presents a challenge to students in an introductory plant pathology course where learning the material is a two-fold process – understanding the different discipline specific content and then applying that content to understanding the broader conceptual information related to plant pathology. A PBL approach would be beneficial in meeting these challenges. PBL students have greater understanding of the organizing principles linking concepts in the subject matter studied (Gijbels et al., 2005) as well as a greater memory of acquired knowledge (Dochy et al., 2003).

In relation to course outcomes '**four**' and '**five**', PBL can support the development of "soft skills" such as written and oral communication, teamwork and self-directed learning (Allen et al., 2011). A distinguishing feature of PBL is that the problem is presented first, and the content then follows. Content is driven by group directed exploration in defining important information and steps required to address the problem (Eberlin et al., 2008). Successfully accomplishing this requires established self-directed learning skills involving goal setting/strategic planning, task strategies and self-reflection/evaluation. We recognize that the self-directed learning skills of students in the course may vary. This presents an opportunity to provide scaffolding around self-directed learning presented as a framework of the phases and sub-processes of self-regulation as described by Zimmerman (2002).

The development of skills to effectively communicate among group members and to stakeholders is a significant part of this PBL project. Successful cooperative learning in PBL requires good team communication strategies (Allen et al., 2011). This presents the opportunity to provide students with a framework to develop interpersonal communication skills. Furthermore, the outcome of this PBL project of a written report to a grower requires students to develop the ability to translate their findings into written communications appropriate for the target audience. Successful communication for this part of the project requires students to understand prior knowledge of their target audience and utilize appropriate language - all key skills for science communication (Mercer-Mapstone and Kuchel, 2017). Activities and assessments to scaffold the development of these skills can be implemented throughout the semester.

PROJECT OVERVIEW: STUDENT ASSESSMENT AND PROJECT EVALUATION

PLPPM 3010 PBL Project Design: Overview		
Name of Project: Developing an Integrative Plant Disease Management Plan		**Duration**: one semester
Project Summary	Working with local stakeholders, student teams will be tasked with assessing local vineyards, orchards, vegetable and other specialty crops for fungal, bacterial, and virus diseases. Over the course of the semester, student teams will design guidelines for scouting and collecting disease samples, assessing field conditions and diagnosing plant diseases. They will generate a report for the grower on integrated plant disease management recommendations based on their compiled results.	
Driving Question	How do we develop an integrated plant disease management plan for a specific cropping system and location?	
Entry Event	Video presentation of a local field or orchard from earlier in the summer with a request from the grower for a disease concern assessment of their planting and the development of an integrated plant disease management plan.	
Public Audience	Local growers that will provide access to their fields and orchards for plant disease assessment.	
Reflection Methods	**Course and Field Work Experience Survey** - Results of this survey will be used to create groups so that there is a range of background knowledge and experience among members.	
	Group/Whole Class Discussion on Inclusive Group Work Environment – Instructors facilitate student development of ground rules for inclusive group. Groups will work through a checklist for establishing group norms. Whole class will come together to share results of group discussions. Groups may further modify group norms based on class discussion but will have a final checklist for their group before the end of the class.	
	Case Study – Provide hypothetical scenario similar to PBL (Case Study: Hosta Takeover: Plant Disease Management Case Study). This case study will be modified to include observers to record student role-play interactions. Groups will work through the case study and then bring observations to a whole class discussion. Key topics and skills covered: disease triangle, pathogen biology and disease management, economic and ethical impact of plant diseases, integrated disease management plan, interpersonal communication.	
	Journal – Using the Blackboard journal tool, students will answer reflection questions about the project every two to three weeks over the semester.	
	Group and Self Evaluations – Self and group evaluations will be conducted mid and end of the semester. Instructors will work with groups to facilitate and work through challenges based on determined guidelines for inclusive group work.	
PLPPM 3010 PBL Project Design: Student Assessment		
Products	**Learning Outcomes**	**Assessments**
Plan of Work (group)	1. Students will be able to examine the concept of disease in the context of natural and agriculturally relevant plant systems.	1. Group completion of initial S.M.A.R.T. goals for project with feedback from instructor. 2. Written scouting plan for site assessment. Identify and/or determine site field

	Sub-goal: Students will be able to use appropriate sources to obtain information about diseases in specific cropping systems. 2. Students will be able to demonstrate effective oral and written communications appropriate for specific stakeholder groups. *Sub-goal 1: Students will demonstrate successful interpersonal communication and collaborative skills through the group development of a project plan of work.* *Sub-goal 2: Students will be able to identify their target audience and develop appropriate communications for that audience.* 3. Students will be able to demonstrate proficient self-regulated learning skills in relation to the development and management of a project. *Sub-goal: Students will be able to develop and apply S.M.A.R.T. goals to define and guide their project.*	conditions, crop information and potential disease problems through review of resources provided in class and online on Blackboard. A rubric with expectations based on learning outcomes and sub-goals will be developed for this assessment. 3. Group development of 1-2 follow-up questions for the grower related to their site assessment to be presented to the grower during the field trip. A rubric with expectations based on learning outcomes and sub-goals will be developed for this assessment.
Field Site Data Collection (group)	1. Students will be able to examine the concept of disease in the context of natural and agriculturally relevant plant systems. *Sub-goal 1: Students will be able to apply the concepts of the disease triangle to identify where to scout in the field.* *Sub-goal 2: Students will be able to maintain detailed field notes and compile data in an electronic file.* 2. Students will be able to demonstrate a good working knowledge of the biology of key plant pathogen groups: viruses, bacteria, nematodes, fungi, stramenopiles, and plants.	1. Groups will collect field data at local grower field/orchard including visual disease assessment, host and site information. 2. Data collected and sources used will be compiled in an Excel sheet and posted on group discussion board on Blackboard. A rubric with expectations based on learning outcomes and sub-goals will be developed for this assessment.

	Sub-goal: Students will be able to use plant disease compendia and field guides to scout for and identify signs and symptoms of plant diseases in the field. 3. Students will be able to demonstrate effective oral and written communications appropriate for specific stakeholder groups. *Sub-goal: Students will be able to demonstrate successful interpersonal communication skills by delegating tasks for the collection of field data.*	
Oral Presentation (group)	1. Students will be able to examine the concept of disease in the context of natural and agriculturally relevant plant systems. 2. Students will be able to demonstrate a good working knowledge of the biology of key plant pathogen groups: viruses, bacteria, nematodes, fungi, stramenopiles, and plants. *Sub-goal: Students will be able to justify a preliminary plant disease diagnosis in the field based on their knowledge of pathogen biology and the disease triangle.* 3. Students will be able to demonstrate effective oral and written communications appropriate for specific stakeholder groups. *Sub-goal: Students will be able to present project details at a level appropriate to an expert audience.* 4. Students will be able to demonstrate proficient self-regulated learning skills in relation to the development and management of a project. *Sub-goal: Students will be able to reflect on their project and identify goals that were met and goals that need to be redefined providing preliminary goals for future work.*	1. Groups will collaborate to develop a 20-minute presentation on the following parts of their project: • Scouting Method • Rationale for disease identification in the field based on scouting • Lessons Learned – What would you do differently if you had to do this project again? 2. Groups not presenting will develop one question to ask presenters. 3. A rubric with expectations based on learning outcomes and sub-goals will be developed for this assessment. Student participation in a Q & A will also be considered as part of the assessment.

Plant Disease Diagnosis Skills (Individual)	1. Students will be able to demonstrate a good working knowledge of the biology of key plant pathogen groups: viruses, bacteria, nematodes, fungi, stramenopiles, and plants. 2. Students will be able to recognize the basics of plant disease diagnostics and integrated approaches to plant disease management. *Sub-goal: Students will be able to identify ascomycete fungi using molecular identification techniques.*	1. Formative quizzes on pathogen groups and laboratory techniques used in plant disease diagnosis. Five quizzes will be given over the course of the semester. One for each pathogen group (bacteria, fungi oomycetes, virus, nematodes. 2. Completion of inquiry-based lab activities and worksheets based on lab activities for each plant pathogen group including molecular identification of an unknown fungal pathogen.
Integrated Plant Disease Management Plan (Individual)	1. Students will be able to examine the concept of disease in the context of natural and agriculturally relevant plant systems. 2. Students will be able to demonstrate a good working knowledge of the biology of key plant pathogen groups: viruses, bacteria, nematodes, fungi, stramenopiles, and plants. 3. Students will be able to recognize the basics of plant disease diagnostics and integrated approaches to plant disease management. 4. Students will be able to demonstrate effective oral and written communications appropriate for specific stakeholder groups.	1. Written report for grower on an integrated plant disease management plan based on locale and cropping system. A rubric with expectations based on learning outcomes will be developed for this assessment.
PBL Project Design: Evaluation		
Content Specific Knowledge Assessment	**PBL Project Pre-Assessment** Survey students online using Cornell Survey Tool at beginning of semester. Background knowledge inventory: 10-15 true/false statements on plant disease diagnosis and management related to pathogen biology, host and environment **PBL Project Post-Assessment** Repeat background knowledge inventory and compare results to PBL project pre-assessment.	
Student Evaluation of PBL	Students will complete an anonymous written evaluation of the PBL project using an adaptation of the University of Delaware course ratings form (http://www1.udel.edu/pbl/forms/course-ratings-form.html).	

SUSTAINABILITY

The PBL project builds on an existing framework of course materials and activities already in place for PLPPM 3010. Currently, course activities include a field trip to a local orchard and plant disease diagnostic inquiry-based lab activities focused on each of the five pathogen groups. The section of PPPMB has a budget is in place for both field trip transportation and lab supplies. Our goal is to expand these activities and create a semester long PBL project in which students can synthesize course content from lecture and lab. With some strategic reorganization, redundancy in lab activities can be minimized allowing for the incorporation of PBL project activities and more modern plant diagnostic techniques such as molecular identification of plant pathogens.

We will design and develop course materials, activities and assessment rubrics for the PBL project to be implemented in the fall of 2018. Evaluation of the project in the summer of 2019 will be utilized to address any areas of the project that need further refinement. It is expected that once the PBL project materials are developed, evaluated and refined the front-end input for each subsequent semester will be much less.

The PPPMB graduate curriculum committee has identified the importance of establishing a field experience for PPPMB graduate students. Discussions with the current PPPMB section chair indicate that the PBL project described in this proposal would be an appropriate learning experience for the graduate students that could fulfill this need. For this reason, the PBL project described in this proposal would most likely be institutionalized beyond the involvement of the PIs.

One area of concern that can be easily addressed relates to securing locations for field trips. Currently, the PIs have established relationships with local cooperators that can fulfill this need. In the future, opportunities for additional collaborations with local growers for field observation and plant sample collection could be leveraged through faculty and researchers in the School of Integrative Plant Science.

BUDGET AND JUSTIFICATION

Year 1 – Summer 2018

Teaching staff support for course development - $10,000

Two-month summer support for teaching support specialist to design and develop materials and activities for the PBL project including entry event video and online materials for Blackboard site, optimize laboratory procedures for molecular plant sample testing and coordinate fieldwork with local collaborators.

Supplies and Materials - $2000

Laboratory supplies and services to be used in the development of a molecular diagnostic laboratory activity.

Year 2 – Summer 2019

Teaching staff support for course development - $10,000

Two-month summer support for teaching support specialist to review PBL project evaluations and refine materials and activities accordingly. Coordinate fieldwork with local collaborators.

TIMELINE

PLPPM PBL Project Timeline Year 1 (2018)							
	June	**July**	**August**	**September**	**October**	**November**	**December**
Project Prep							
Arrange field trip with local grower							
Create entry event video							
Design and develop PBL learning resources for online materials and face-to-face activities.							
Pre-Project Activities							
Background Knowledge Inventory							
Class and Field Experience Survey							
Case Study and Inclusive Group Work Discussion							
Project Activities							
Lab Activities							
Reflection Journals							
Group and Self Evaluations							
Oral Presentation							
Integrated Plant Disease Management Report							
Student PBL project evaluation							
Repeat Background Knowledge inventory							

PLPPM PBL Project Timeline Year 2 (2019)							
	June	July	August	September	October	November	December
Post-Project Evaluation of Year 1							
Compile and review PBL evaluations							
Compile and compare pre and post PBL background knowledge inventory							
Identify PBL project strengths and weaknesses and plan for Fall 2019							
Project Prep							
Arrange field trip with local grower							
Create entry event video							
Edit and/or update PBL course learning and teaching resources based on post-project evaluations							
Pre-Project Activities							
Background Knowledge Inventory							
Class and Field Experience Survey							
Case Study and Inclusive Group Work Discussion							
Project Activities							
Lab Activities							
Reflection Journals							
Group and Self Evaluations							
Oral Presentation							
Integrated Plant Disease Management Report							
PBL evaluation							
Repeat Background Knowledge inventory							
Post- Project Evaluation of Year 2							
Repeat Year 1 post project evaluation							
Identify PBL project strengths and weaknesses and adjust for Fall 2020							

APPENDIX

Literature Cited

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CALS Active Learning Proposal Evaluation Committee
College of Agriculture and Life Science
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Dear Evaluation Committee Members:

I am writing in strong support of the proposal by Kerik Cox and Mary McKellar to develop and implement a problem-based learning project to enhance the learning outcomes for my Section's foundational course, PLPPM 3010, Biology and Management of Plant Diseases. This is a pre-requisite course for our graduate curriculum in PPPMB. It is required for the baccalaureate Plant Science major in the Plant Pathology and Fungal Biology minor concentrations. It is also an elected requirement for Crop Management minors and for Plant Breeding and Genetics and Sustainable Plant Production minors in the Plant Science major. I agree with the project leaders that our students, graduate and undergraduate alike, need a stronger experiential connection with plant diseases in field production contexts. The activities proposed in this project will indeed go a long way in accomplishing those goals. The direction of student teams to assess field problems and make oral and written reports to stakeholders affected by these plant problems adds greatly to learning skills of each student involved. I am quite enthused by the added student value that these activities will bring to the PLPPM 3010 experience.

Over time, the new field learning and communication activities proposed in this project provide an excellent opportunity to involve other PPPMB faculty and staff in providing relevant field-based experiences for students. I am personally glad to volunteer in this regard. My Section colleagues and I are committed to sustaining the changes implemented through this project for future iterations of PLPPM 3010. I commend Kerik and Mary for their vision and planning of amendments to PLPPM 3010 that will greatly benefit every student who takes the course. I will do whatever I can as chair and colleague to support and sustain their efforts. This includes the allocation of Section funds to provide transportation necessary for field visitations and meetings with stakeholders.

If I may answer further questions, feel free to contact me at gcb3@cornell.edu or give me a call at 607-255-7849.

Sincerely,

Gary C. Bergstrom

Gary C. Bergstrom
Professor and Chair