EXPERIENTIAL LEARNING INSIDE THE CLASSROOM

CREATIVE PROJECT

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Introduction

Ball State University is an institution dedicated in helping students achieve a higher level of education through innovative teaching styles, research, and programs designed to give experience outside the classroom (1). One of the ways Ball State achieves this mission is through the Virginia Ball Center for Creative Inquiry. This center is designed to give students a semester long immersive learning experience outside of traditional classroom teaching (2). This project-driven style of teaching allows students of different discipline backgrounds to work together to produce a tangible outcome whether it be a documentary, a program that can be broadcasted, or a future academic publication (2).

However, this style of project-driven teaching does not have to be limited to this educational setting that the Center for Creative Inquiry provides. This type of learning has been incorporated into the traditional classroom setting through the approach of project-based and experiential learning. This approach to teaching drifts away from the traditional styles found in the science classroom, which usually consist of lecture and “cookbook” laboratory activities, and engages students in a more progressive research-oriented approach.

The purpose of project-based and experiential learning is that students gain knowledge of the subject and are able to synthesize information together rather than simply memorizing certain facts and concepts (3,4). Through experiential learning students are engaged in their own discovery much in the same way as a scientist working in the field (3). Much of science is about asking the question and then finding the answer. Project-based learning gives the student the concrete
experience of understanding how to examine the world around them, and find answers to those questions (4).

The experiential learning and project-based learning style described above has been incorporated into the classroom as research study for undergraduates (5). Through research the student becomes, in a sense, the teacher by being the one to form the hypothesis, conduct the research, and form the conclusions about the findings gained (6,7). This style of research oriented teaching also helps prepare the undergraduate for what he or she might experience in graduate school or even in a professional career setting (5).

Over the course of the semester, the student gains knowledge of the area they have chosen to research. This knowledge is gained through the process of learning that takes place described by Zion et. al (8) as follows: learning proper documentation, how to make connections between information, how to research current literature on the subject, importance of dedicating time, understanding that changes will take place when answers are found to questions asked, and ultimately the understanding of basic procedures in experimentation will be better understood. This process of learning is in essence the goal intended for the students who are participating in the course. The hope is that through experiential learning the student will take command of their education and learn the key concepts through experience in the lab instead of through rote memorization of facts.

**Methods and Materials**

The two courses examined for this study are Bio 341/641 Pathogenic
Bacteriology and BIOT 491/591 PCR Methods and Applications. The laboratory portion of each of these classes are student research. As outlined in Trempy's “Learning Microbiology Through Cooperation” (9), the students pick a research topic of their choosing (as appropriate for the course itself), creates a research proposal outlining what they plan on studying and how they intend on performing their study, researching current literature on the topic, conducting the research in the lab, and finally writing a manuscript of their findings as tangible evidence of the research itself.

In turn, what we examined was the advancement of the students' understanding of course material through the use of research as a form of experiential learning. To examine this we designed pre and post survey questions to be given to the students at the beginning and end of the semester. The purpose of giving both a pre and post survey is to examine, through quantitative means, whether or not the students are achieving the type of learning the course has set out to provide (10). What we are looking for is a change or advancement in the better understanding of how the scientific process truly works when put into action. The survey can be found in Appendix A.

The questions in the surveys are based after the tests given by the Rios-Velazquez et. al (11) study “The Delta Cooperative Model.” Their aim was to determine how well a biology workshop helped students (who had little to no exposure to biology) better understand the inner workings of the science. Similar to our goals, they hoped to give some exposure to research and interaction with other students (11).
The second half of the research we conducted took on a more qualitative approach. The qualitative approach used was the Case Study, which examines a “bounded system” (in our case the research conducted by the students) through a series of observations and interviews (12). We spoke to the students individually or in groups (using in class student updates on how their research was coming along) to learn whether or not the students were enjoying the work they were doing, interesting aspects they found while researching, or if they had come across any bumps in the road while working in the lab.

**Results**

The answers to questions one through five of the administered survey were analyzed using the T-test to determine if there was any significant difference between how the questions were answered at the beginning of the semester compared to how the students answered them at the end of the semester. The averages for each question were graphed and can be found in Figure 1 (PCR class) and Figure 2 (Pathogenic Bacteriology class).

As shown in Fig. 1, for questions one, three, four, and five students on average answered the quantitative statement scoring themselves higher (on a scale of 1-5; 1 being the lowest and 5 being the highest) on the post survey than on the pre-survey. These differences in scores showed to be significantly different from each other by having a P-value of less than or equal to 0.05 when the T-test was calculated.

As shown in Fig. 2, Question four was the only question to have significantly different answers (a P-value being less than or equal to 0.05) when
comparing pre-survey and post survey answers. For all of the other questions, the students in the Pathogenic Bacteriology course seemed to answer the questions the same way for both the pre-survey and post survey.

The second half of the survey consisted of qualitative questions which were used to determine how confident a student was in the lab setting, and to inquire how much laboratory research experience that student may or may not have. The general responses to these questions can be found in Fig. 3. Most of the students enrolled in the PCR course did have prior research experience before taking the course as either an undergraduate or a graduate student, and for the most part the work was collaborative but not necessarily interdisciplinary. Many of the students enrolled in the Pathogenic Bacteriology course did not have prior research experience; however, those that did have research experience had both collaborative and in some cases interdisciplinary work experience. Students in both courses were satisfied with the class and felt that the class met their expectations in both course material and learning.
Figure 1: Statistical results of Questions 1-5 for the PCR class. This figure represents the average answers that students gave for each of the five quantitative questions asked on the survey. The asterisk over the bars representing the post-survey averages indicates that the answers were significantly different that the pre-survey answers with a P-value ≤ 0.05.
**Figure 2:** *Statistical results of Questions 1-5 for the Pathogenic Bacteriology class.* This figure represents the average answers that students gave for each of the five quantitative questions asked on the survey. The asterisk over the bar representing the post survey averages indicates that the answers were significantly different than the pre-survey answers with a P-value \( \leq 0.05 \).

**PCR**

**Question 6:**
- Most students have either undergraduate or graduate research experience
- Their research experience ranges from Ecology, Microbiology, medical biological sciences, and even research experience in Chemistry
- Student research has been collaborative but not necessarily interdisciplinary or with outside community affiliates

**Question 7:**
- Students hoped to gain the knowledge and experience of performing a PCR experiment
- All students felt as though the class met their expectations

**Pathogenic Bacteriology**

**Question 6:**
- Most of the students have little to no research experience
- The students who do have research experience have studied in the fields such as Ecology, medical biological sciences, and Chemistry
- Students who have research experience stated that their experiences were collaborative and in some cases even interdisciplinary but they did not necessarily collaborate with partners within the community.

**Question 7:**
- Students expected to refine their laboratory techniques, to become more confident and comfortable in the lab, and to learn how to ask critical questions in researching.
- Students felt that their overall expectations for the class were met and they also felt that they were more proficient in laboratory techniques.

**Figure 3:** Table of Quantitative Results from survey questions. The answers shown are the general answers given by students in each of the classes for Questions 6 and 7.

**Discussion**

The students in the PCR class tend to be more experienced in research since it is an upper level biology course than the students enrolled in the Pathogenic Bacteriology course. However, in terms of students rating themselves based on the statements presented in the pre and post survey questions (Questions 1-5), there was more significant difference between the surveys in the PCR class than there were in the Pathogenic Bacteriology class. The students in the Pathogenic Bacteriology class mainly focused on refining their laboratory skills, whereas the students in enrolled in the PCR course focus on learning a whole new skill set. Because of this course material difference this could be the rationale behind why there was more significant difference between the answered questions in the PCR course than in the Pathogenic Bacteriology course.

Students in both courses felt that their expectations of the class were met through the material that was taught in lecture and lab. Because their expectations
were met this can also conclude to why the students scored themselves higher on the quantitative portion of the survey given at the end of the semester.

The majority of students enrolled in the PCR class had either undergraduate or graduate research experience; whereas most of the students enrolled in the Pathogenic Bacteriology course have little to no experience in the research field. Keeping in mind that these courses are of two difference levels, the goal that students felt was accomplished in both courses was to introduce new topics in each field of study, help students learn the proper laboratory techniques, and finally give them the experience of creating a hypothesis to further inquire on topics that had been presented in class that they could test in the lab setting.

Research in the undergraduate and graduate classroom setting can be very beneficial to the student. By participating in research, the student is acquiring and refining laboratory skills that will be needed in the job field (13). This hands-on approach is better preparing students for the workforce and helping them to better understand the key concepts taught in the classroom (13).

However, if not approached objectively laboratory class research experience can hinder a students' learning. Like any teaching style there is always a downside (14,15). Some of the disadvantages could be dysfunctional student groups, a lack of preparation, and possibly the interference of other studies (14,15). It is the instructor's responsibility to make sure students stay on track and fulfill the required goals of the research experience. With proper guidance and preparation the research experience can be very beneficial and rewarding to the student.
References


Appendix A

Please answer the following to the best of your ability.  
1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree,  
5=strongly agree  
For questions 6 & 7 please give as much detail as possible.

1) I know how to develop a testable research hypothesis.  
   1 2 3 4 5

2) I know how to write a formal scientific research paper.  
   1 2 3 4 5

3) I fully understand the scientific method and how to apply it.  
   1 2 3 4 5

4) I know how to gather and calculate relevant statistical data.  
   1 2 3 4 5

5) I understand how to systematically analyze a scientific research article.  
   1 2 3 4 5

6) Explain any prior research experience you have.

   a) Has your research been interdisciplinary? (Yes or No)

   b) Has your research been collaborative? (Yes or No)

   c) Has your research involved a community partner? (Yes or No)

7) What are your expectations for this class/Did this class meet your expectations?