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How 'Salmon in Trees' Leads to Greater Student Engagement in First Year Biology

Susan Purdy

Thompson Rivers University, Department of Biological Sciences, 900 McGill Rd., PO Box 3010, Kamloops British Columbia V2C 5N3 CAN
(**spurdy@tru.ca**)

The 'Salmon in a Tree' project was implemented in our First Year Biology labs in 2012 as a way to increase student engagement as well as to integrate some of the core competencies that we require of our students. This project required students to work in teams to answer a quirky biological question and communicate their answers in writing and by a video. After giving an overview of the project, the results from a student survey were discussed in regards to the team-based aspects of the project. Lastly, the discussion focused on the challenges and opportunities of team work and the use of peer-evaluations.

Keywords: team-based learning, peer-evaluations, student engagement

Introduction

Educational research in the STEM (science, technology, engineering and math) disciplines has shown that students learn more when class time is given over to active learning and where students have the opportunity to spend more time actively engaged with the subject matter (Wood, 2009). This includes opportunities for students to solve problems together in small groups by working cooperatively and collaboratively (Carmichael, 2009). The AAAS (2009) document 'Vision and Change in Undergraduate Biology Education' makes several recommendations including: engage students as active participants, relate abstract concepts in biology to real-world situations, stimulate the curiosity students have about learning about the natural world, and develop life-long science-learning competencies.

There are often impediments to implementing team-based and active learning in large first-year lecture classes, but luckily there are opportunities to do so in our first year laboratories. Here students are scheduled to spend three hours a week in smaller groups already and the nature of the lab is that they are intended to be places for active learning. In 2012, we implemented a new team-based project in the First Year major's labs that occurs in the latter half of the semester. The project is based on the 'Heifer in a Tank' project that was developed at the University of Alberta in their Agricultural Science program (Robinson *et al*., 2006). Some of the goals of this project were to help their students develop higher level skills such as critical thinking and problem solving, provide a forum to develop skills in team-work, as well as promote a greater sense of community in their first year cohort. The premise of the project is that students work in teams to investigate and communicate the answer to a quirky question. This project requires students to work collaboratively in teams, and as such, we had to investigate and then implement strategies to help aid in the success of the teams.

Overview of the Project

This project is just part of the line-up of labs and assignments we have in our First year Biology Majors labs. Overall the project is worth 15% of the course grade. The name we chose for this project, *Salmon in a Tree,* is based on the first question on a list of quirky questions, "why is there a salmon in a tree?' that we had students choose from. The lecture portion of the course focusses on evolution, diversity and ecology, and so the questions we provide to the students all have one or more of these overall themes. We ask the faculty in our department for question suggestions several months before the project is set to begin. We need approximately 25 new questions each year, as our First Year Biology class has approximately 250 students, divided into 12 lab sections. The teams consist of three to five students, and we have about four to five teams per lab section – so each question could be used a possible three times. Sometimes the questions provided relates to a particular faculty member's research or research in an area that they are familiar with – so a team that picks this particular question is able to connect with them personally. Other questions can come from research articles that faculty have read recently, or a topic that is in the news that relates to these themes (Table 1.)

Table 1. Sample Quirky Questions from 2013.

• How do Canadian monarchs find their way to Mexico?
• Why do some pitcher plants like having bats sleep over?
• Why are bluebirds blue?
• Why do the mating rituals of some male wasps resemble what happens in a nightclub at midnight?
• When and why are black bears white?
• Why does dwarf mistletoe resemble a cannon?
• Why do ground squirrel tails light up (in infrared)?
• Will adding iron to the ocean help the planet escape from heating up?
• Why are mushrooms like zombies?

The teams themselves are formed around interest in a particular question. This is actually the second team-based project that we run in the labs for this course – the first being an inquiry based lab where students run their own devised experiments to investigate some aspect of an invertebrate animal's behavior. These teams are formed by the lab instructor based on a questionnaire students fill out. For this team-based project students have the option of working with the same teammates as they had previously, or working with new team members. The first time we ran this project the team sizes were between five to seven people, but based on a feedback survey of the students, this was deemed to be too large a group, so the teams are now between three to five people.

The teams are formed and questions assigned about six weeks before the end of the semester. The students then attend a library session where they learn how to search for and differentiate between sources of information, discriminating between non-academic and academic information sources as well as peer-reviewed and non-peer-reviewed sources. Students are also taught how to cite and use their sources correctly. Then as a team they develop a bibliography of sources that would help answer their question. This bibliography is marked and returned to the students in a timely fashion as students then need to individually write a 350 word response to the question citing the appropriate literature correctly. As a team the students also need to create a 4 to 5 minute video that answers their quirky question in an entertaining, but scientifically detailed manner. Based on feedback from the students in the previous year, the schedule was shuffled to introduce the *Salmon in a Tree* project earlier on in the semester, so now students have more than 4 weeks to work on this video, but also at the same time there is a 2 week investigative lab on C-fern life-cycles that requires the students to write an individual report.

The culmination of the project is a video showcase which we advertise widely to the university community. Of the approximately 50 videos produced by the students, the top 13 are chosen based on a marking rubric that at least two to three Instructors have used while watching the videos as well as questioning the teams about their quirky question. The video showcase is in the evening in a large auditorium during the last week of the semester and all the students in the course are encouraged to attend, along with friends and family and interested members of the university community. The audience votes for their top three favorite videos and awards are handed out at the end of the evening.

Learning Objectives for the Project

The instigation for this project came about by our desire to give our first year Biology students some different learning outcomes than we had previously been able to give them in our more traditional labs which relied heavily on learning content. The labs that we use now are more process driven, where we want students to become more familiar with the 'process of doing science' but there is still a certain amount of information that we require them to know. For the '*Salmon in a Tree*' project the learning objectives for our students include the following:

- Use the available library resources to find, differentiate between and correctly use academic information sources;
- Communicate biological concepts effectively both in writing and verbally;
- Become familiar with some of the research being undertaken by our own faculty members or current research elsewhere in the field of evolutionary biology, ecology and biodiversity;
- Develop problem-solving skills and other interpersonal skills required to work effectively in a team of their peers;
- Develop a sense of community with other first year Biology students and the Biology faculty and by doing so improve student engagement in our first year cohort.

Peer-evaluations

Students marks are based on the team mark they received from their video and bibliography as well as the individual mark they received for their research article. The team based marks are adjusted according to their peer-evaluations. The peer-evaluation process is a necessary part of team-based projects as it gives students a way of assessing accountability (Michaelsen and Sweet, 2008). Students rate themselves and each of their team mates in various categories (see Table 2.)

We previously used a more simplistic rubric that required the students to evaluate each other based purely on performance, i.e. what they contributed to the final product. We found, though, that this did not adequately address all the necessary traits that make a good team member such as a respectful attitude, good time management and communication skills. Upon searching the literature we found a much more detailed rubric that we could adapt for our use by Van den Bogaard and Saunders-Smit (2007) that they developed for aerospace engineering team-based projects.

Table 2. Peer-Evaluation Form.

Rating	Job Performance	Attitude and interaction with team members	Leadership and Initiative	Team meetings and time management	Communication within the team and for the project
Excellent	Consistently did more than required. Work is of exceptional quality.	Positive attitude which favorably influenced others. Actively encouraged and supported the other team members. Made sure to find out people's strengths, and encouraged them to use them.	Took initiative to seek out work, very involved in the planning of the team, and how the project was progressing. Took on a leadership role and led team discussions.	Used time effectively and got tasks done on time. Used and encouraged the team to use meeting time effectively. Was always on time for meetings, even showing up early to be prepared.	Oral and written skills excellent. Communicated with the other team members on a continual basis. Responded to emails very quickly.
Good	Sometimes did more than required. Work was of high quality.	Positive attitude toward the project and team members. Helped fellow team members when needed. Always respectful of other team members.	Readily accepted tasks, and actively involved in the project. Sometimes led team discussions.	Used time effectively to get tasks done. Completed all tasks on time. Always on time for team meetings.	Good written and oral communication. Communicated with the team members regularly. Responded to emails in a timely fashion.
Satisfactory	Performed all assigned tasks. Quality of work was acceptable.	OK attitude, sometimes helped other team members. Mostly respectful of other team members.	Got involved enough to complete tasks. Did his/her share. Participated in team discussions	Wasted some time when working with the team, but worked hard when deadlines were near to get the task completed. Mostly on time for meetings.	Generally got the pointy across and tried to improve in weak areas. Responded to emails within a day or so.
Ordinary	Often did the tasks assigned. Quality was ordinary.	Neutral attitude. Was neither positive or negative about the project. Did not help other team members very much	Did his/her share of the work, but had to be asked to do so. Medium participation in team discussions	Completed the majority of the tasks assigned on time, but only after reminders. Not often on time for meetings	Written and oral communication skills were passable, but could be improved. Communicated ok with the team.
Marginal	Did not perform all the assigned tasks, and those that were done sometimes needed to be repaired or re-done.	Negative attitude toward the project and/or team members. Sometimes disrespectful of fellow team members.	Tended to watch others work, got involved only when necessary. Did not participate very much in team discussions.	Wasted a lot of the group time. Was seldom seen doing any productive work. Some tasks were completed late. Mostly late for team meetings.	Written and oral skills ineffective, and made little effort to improve them. A poor communicator with the team. Responded very slowly to emails.
Poor	Performed few assigned tasks, and those that were done had to be redone.	Very poor attitude. Could be unhelpful or disruptive. Disrespectful to others.	Took no initiative at all. Tried to do the least work possible. No participation.	Never completed any of the assigned tasks on time. Wasted his/her time as well as others.	Communication skills very poor. Made no effort to communicate with the team.

The ratings for each of the students are converted into a numerical number as shown below and averages were calculated from all their peer-evaluations.

- Excellent = 100
- Good = 87
- Satisfactory = 75
- Ordinary =63
- Marginal =50
- Poor = 25
- No show = 0

The ratings are then used in a calculation as outlined by Oakley *et al*. (2004) where individual grades are compared to a team grade. For example if a student received a number the same as the team average then this student's final grade for the project would not be adjusted. If the student's number was less than the team's average then the final grade would be adjusted lower, and if the student received a number higher than the team average then his or her grade would be adjusted higher. According to this method, no grade can be adjusted higher than by 1.05 or 5%. Depending on the peer evaluations, some student's final grade can be significantly lower than the other team members if they have been rated poorly by the majority of their team mates.

Results from Student's Survey

Following the end of the project the students were surveyed about several aspects of the project in order to determine if the project was meeting our learning objectives. In particular we wanted to know what the students felt about the team-based aspect of the project (Table 3.)

While these responses show that 26% of the class did not appear to enjoy the collaborative nature of the project as well as the whole experience (13%), the majority of the students do appear to have enjoyed the team-based nature of the project and the whole experience overall. Interestingly only 8% of students did not think the peer-evaluation process was fair; so while some of students did not enjoy the team-based project they did recognize the value of the peer-evaluation process, and also only 10% of the students felt their teams did not function well together. So these results seem to suggest that the majority of students (72%) thought that their teams functioned well and they enjoyed the whole project (60%). I asked the question about inserting a peer-evaluation part-way through the project to help facilitate better team function, but it appears the majority of students were either neutral about this idea or disagreed with it. However, 22% of the students though this was a good idea, and Oakley *et al*. (2004) recommends doing an evaluation of team functioning part-way through a large project, so likely we will implement this next year. However rather than doing a peer-evaluation where students rate their peers, it may be better to do an evaluation of overall 'team functioning' which would be shared among the team members for discussion.

When asked to comment on the project one student responded "a good way to learn in groups – seemed scary at first, but overall a good experience." Another wrote 'having 4 to 5 people in a group really helped the project and made it work better.' However another student wrote 'my group was dysfunctional and one member almost impossible which affected the quality of the project.'

Challenges and Opportunities with Team-Based Projects

By converting our labs to being more inquiry-based and requiring more collaboration and team-work among the students we have created many new challenges that we did not have to previously confront as Instructors. The rewards, though, we think are worth the head-aches, and if we can keep the end-goals in mind and work through the challenges, the opportunities for improving the learning experiences and

Table 3. Student responses (n =133)

Question	Response
I would have preferred to work on my own to undertake this project	26% agreed or strongly agreed 26% neutral 47% disagreed or strongly disagreed
I enjoyed the collaborative nature of this team-based project and felt this was a good way to work on a large project	57% agreed or strongly agreed 15% neutral 22% disagreed or strongly disagreed
I felt my team was just the right size in terms of numbers of people	76% agreed or strongly agreed 11% neutral 14% disagreed or strongly disagreed
I felt my team functioned well together	72% agreed or strongly agreed 16% neutral 10% disagreed or strongly disagreed
I thought the peer-evaluation process was fair, and allowed me to evaluate my peers in a meaningful way	78% agreed or strongly agreed 14% neutral 8% disagreed or strongly disagreed
I would have liked to have a chance to evaluate my peers and give feedback to them part-way through the project	22% agreed or strongly agreed 38% neutral 24% disagreed or strongly disagreed
Overall I enjoyed the 'Salmon in a Tree' project	60% agreed or strongly agreed 25% neutral 13% disagreed or strongly disagreed

outcomes for our students are great.

There has been much written on team-based learning and in particular the advice of Oakley *et al*. (2004) has been very helpful. They advised that teams should be Instructor-formed and that teams should contain a mixture of stronger and weaker students and that at-risk minority students should not be isolated in a team. They also recommend team size to be between three to five students. The authors recommend having each team form their own guidelines by developing a 'team policy and expectations agreement' that sets to establish roles and responsibilities for each team member, as well as strategies for dealing with uncooperative team members. This is something we have not instigated, but we will do so in the future. These authors also strongly advise that peer-ratings are an essential part of the team-based learning as they "are an effective device for improving team performance."A student response in our final questionnaire highlights the issue of unequal performance – "I definitely put more into the project than some of my team members, and I dislike that they still got equally marked as me – they got credit for my work." This would have been accounted for if the peer-evaluations had showed that he/she had done more than their share, and others had done less. Peer-evaluations are an effective way to adjust student grades to take into account unequal performances.

Michaelsen and Sweet (2008) reiterate many of same suggestions of how to promote the success of team-based learning, where they list four main criteria. Teams need to contain members as diverse as possible, taking into account a student's previous work or academic experience, and breaking up already formed coalitions such as friends and partners. Team members must be held accountable for their performance. Feedback must be provided to the team frequently and lastly the assignment itself must be of a design that promotes learning and team development. This last point is interesting, as the authors suggest that the type of assignments that fits best with the team-based learning approach should be 'significant' in that it requires some higher-level problem solving abilities as well inputs from a group of people. The 'Salmon in a Tree' project fits these criteria nicely.

Overall the experience with the 'Salmon in a Tree' project over the last two years, has been a positive one. The learning objectives for the project are being met, and the majority of students seem to enjoy the project and have a positive experience. There are certainly components of the team-based process that need to be improved upon though, such as a mid-project team review and also some more guidance for proper team functioning including having the students produce their own team's roles and responsibilities document. The videos produced by the students are a testament to the success of the project. (**http://www.tru.ca/science/programs/biology.html**)

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About the Author

Susan Purdy is a Lecturer in the Department of Biological Sciences at Thompson Rivers University and teaches Environmental Biology to non-science students as well as being the Lab Coordinator for Biology 1210, and she also teaches the second year Animal Body Plans labs and the third year Animal Behaviour labs. She has an undergraduate degree in Biology from the University of Kwazulu-Natal in South Africa and a Master's degree in Natural Resources Management from the University of Manitoba, Canada.

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