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Introduction

- Employers are looking for graduates with a high level of interdisciplinary, collaborative, and globally-oriented skills (National Academy of Sciences, 1995), including communications, conflict resolution, and planning/project management.
- Students need more practice in group activities to prepare them for those aspects of career that require collaboration; more instruction in group functioning and assessments that promote and evaluate learning is needed (Sorensen and Lunde, 1993).
- In recent years, higher education has shifted from a strictly instruction-based curriculum to include more collaborative learning activities using online platforms like Google Docs (Chu, 2008; Chu and Kennedy, 2011).
- Collaborative learning is an educational approach to teaching and learning where groups of students work together to solve a problem, complete a task, or create a product (Laal and Ghodsi, 2012; Sorensen and Lunde, 1993).
- Instructors use collaborative learning as an educational tool to: improve student skills in working and communicating with others, enable students to learn from one another, and enrich student experience in course content (Keleman and Spich, 1984).
- From a pedagogical perspective, group projects as part of collaborative learning are beneficial for workplace, student, and instructor purposes (Young and Henquinet, 2000).
- Advantages of collaborative learning include social, psychological, academic, and assessment benefits, as collaborative learning is based on cooperation of team members and not competition between students (Laal and Ghodsi, 2012; Laal et al., 2013).

Objectives

- Develop an inter-institutional cooperative learning project during which students work via distance to create a single-document literature review of environmental factors that affect flowering and fruiting of crops produced in high tunnels.
- Evaluate the effectiveness of the collaborative learning experience based on changes in 1) student perception of group projects; and 2) student perception of their confidence in knowledge about the topics researched.

Materials and Methods

- A written pre- and post-project survey instrument included statements that evaluated 1) student perception of group projects, and 2) student confidence about knowledge of environmental impacts on crops produced in high tunnels. Students responded using a Likert-type scale to indicate strong agreement (6) to strong disagreement (1) with each statement (Table 1). Open-ended, qualitative data was also collected with the post-survey.
- The pre-survey instrument was administered in the second week of the Spring 2015 semester to six undergraduate students enrolled in HORT 625 *Floral Crops Production and Handling* at Kansas State University and two undergraduate and two graduate students enrolled in HORT 5422 *Flowering and Fruiting in Horticultural Crops* at Oklahoma State University.
- Students were assigned to groups of two or three by the instructors so that each group had at least one student from both universities. To facilitate project completion, five sequential written instructional documents were developed to move students through the project's process (Figure 1).
- The post-survey was administered two weeks before final exams. All students participated in both surveys without compensation (n = 10). Paired t-tests were used to compare pre- and post-survey responses in Microsoft Excel 2013.

Figure 1. Mind Map of five sequential instructional phases that were developed and given to the students as unique documents throughout the semester.

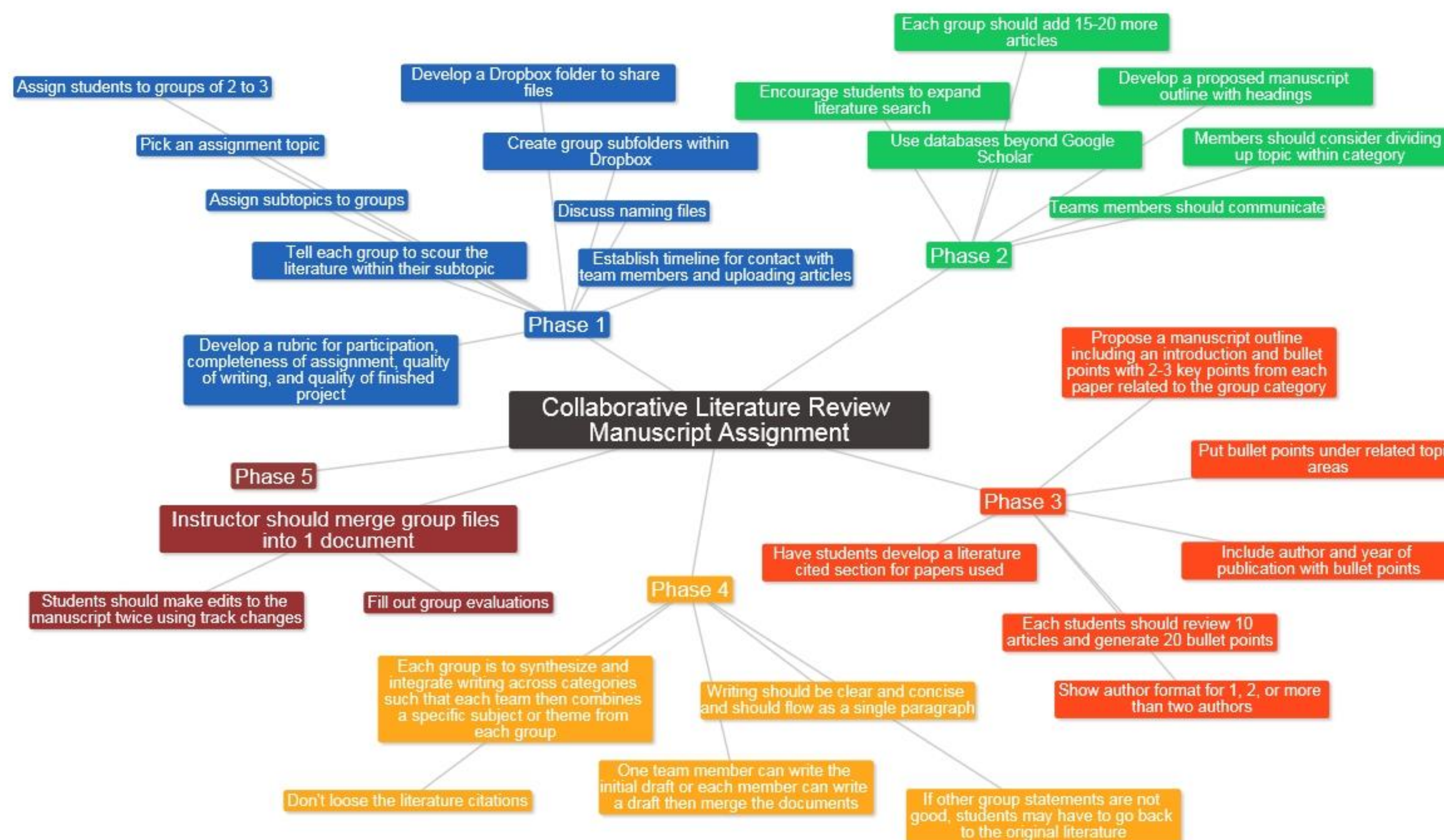


Table 1. Student responses to pre- and post-project survey items from an inter-institutional collaborative project between students taking a similar, upper-level undergraduate course from Kansas State University and Oklahoma State University during Spring 2015 (combined n = 10).

Survey Statements about Group Work Preferences	Pre-survey Average ^a	Post-survey Average ^a	t-test Value ^b
I prefer group projects to typical class assignments.	3.0	3.2	0.591
I enjoyed collaborating with student colleagues at [Kansas/Oklahoma] State University.	4.4	4.0	0.269
I have collaborated with students from another university on a project before.	1.8	1.9	0.780
I can see how collaborating with students from another university on a project can increase learning.	4.8	4.3	0.096
I found it challenging to schedule communication with group members from a different university.	3.6	4.1	0.529
I put more effort into the project than a normal group project since students from a different university were involved.	3.9	4.1	0.619
Working towards a project goal of developing a review manuscript for publication interests me more than a typical class assignment.	4.1	3.3	0.153
Group projects help me better understand what is taught in a class.	3.6	3.6	1.000
Group projects are simply busy work.	2.5	2.4	0.758
Group projects allow me to directly apply class concepts.	4.4	4.4	1.000
I learn more when I work with others.	3.7	4	0.496
Group projects do not add to what I learn in class.	2.5	2.5	1.000
Group projects cause me to earn a better grade in the course overall than I would have on my own.	3.9	3.0	0.019*
Group projects will benefit me in my future career.	4.9	4.4	0.178
Working alone on a class project is more desirable than working in a group.	3.2	4.2	0.052
Working with a team on a class project is stressful.	4.3	4.5	0.556
Working in groups enhances team-work skills.	4.7	4.8	0.678
Working on a project as a part of a team makes it easier to get the job done.	4.2	3.8	0.173
Group projects have helped me learn how to more effectively deal with people.	4.2	3.9	0.279
Group projects tend to create conflict between students.	3.65	3.6	0.840
Groups should resolve any conflict that occurs between team members without involving anyone outside the group.	3.9	3.5	0.373
The professor should help resolve conflicts among group members.	3.5	3.5	1.000
In my experience with group projects, there tends to be at least one person on my team who does not contribute their fair share.	5	4.6	0.269
I picked up the work load of the person not doing their fair share.	4.4	4.1	0.718
If a person does not do his/her fair share of the group work, I will give them a poor evaluation at the end of the semester.	5.1	4.5	0.168
Survey Statements about Knowledge Gain			
I am confident that I can review the literature to understand the physiological response related to a certain crop.	4.7	4.8	0.541
I have a thorough understanding of how the flowering response of crops is influenced by production in high tunnels.	2.9	4.4	0.001***
I understand how all of the aspects of light—quality or wavelengths, duration or photoperiod, and quantity or intensity—interact to influence a crop's flowering response.	3.4	4.6	0.013*
I am confident that I know how to manipulate the environment (light, temperature, etc.) to influence a crop's flowering response.	3.3	4.8	0.005**
Nearly all crops show a similar flowering response to a given environmental treatment (light, temperature, etc.).	2.5	2.9	0.462
I am confident that I know how to manipulate the fertilization of a crop to influence its flowering and fruiting response.	3.4	4.3	0.041*
Research with horticultural crops provides the basis for growers to innovate their production practices.	5.1	5.3	0.343

^aTo what extent students strongly disagreed (1), disagreed (2), somewhat disagreed (3), somewhat agreed (4), agreed (5), or strongly agreed (6).
^b*, **, *** Representing significance at P ≤ 0.05, P ≤ 0.01, P ≤ 0.001, respectively.

Results

- Student perceptions about group work did not change appreciably from before to after collaborating on this project. The only statement that showed a change in student perception from pre- to post-project was whether "group projects cause [students] to earn a better grade than [they] would have on [their] own" (Table 1). Students perceived that the group project resulted in them earning a *lower* grade.
- Student perceptions of their knowledge gain about how light, environment, and fertilization influence a crop's flowering response in high tunnels improved after completing their respective courses, of which the project was a key part (Table 1). However, students did not report increased confidence in being able to review literature or more strongly perceive that research provides the basis for growers to innovate their production practices, perhaps because they already agreed with these statements in the pre-survey.
- In the post-survey qualitative questions, students were asked whether the project, with improvements, should be included in future offerings of the course. Eighty % said 'Yes,' 10% said 'No,' and 10% did not clearly indicate their opinion (n = 10).

Discussion

- Instructors were surprised by how ill-prepared upper-level students were to find and summarize literature, then extract cohesive ideas from their summaries. On scale of 1 to 10 with 1='manuscript is unreadable and difficult to follow' and 10='manuscript should be submitted for publication, instructors rank the final manuscript at 4.5. The average of student ratings of manuscript quality was 7.1, indicating that they recognized that it was not publication-quality.
- On a scale of 1 to 10 with 1='I contributed very little to the project' to 10='I contributed my share and probably more to this project,' average student response was 7.6. This result may help explain student perception that the project decreased their grade compared to working alone.
- Despite student agreement that they were confident in reviewing the literature to understand physiological responses, instructor observation paired with several student comments suggested that more instruction should be given on how to conduct a proper literature search.
- Other qualitative student comments about how to improve the project included: more clearly conveying the project process from the beginning and throughout; better explanation and instruction on how to use Dropbox or use a different program to share documents; select a more general topic; provide instruction on how to communicate with partners; provide more updates and require more submissions to check on progress; and perhaps the project would be more valuable if each *group* created their own manuscript.
- Student perception of group work was generally lukewarm, both before and after the collaborative project. For example, they only somewhat agreed that 'I prefer group projects to typical class assignments' (Table 1).

Conclusions

- Instructors should consider spending a whole lecture on explaining the project and showing students how to perform a literature search, cite the literature, develop a Literature Cited section, track references, and use technology such as Dropbox to share documents. Alternatively, extensive supporting documents in addition to the written Project Phase documents (Figure 1) must be provided.
- Though frustrating for students, the use of inter-institutional collaborative learning such as reviewing literature based on a topic of interest can promote confidence related to content knowledge gain.

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