Incorporating Student-Centered Learning in an Ecosystems Course

By Suchinta Arif

Student-centered learning broadly encompasses teaching approaches that shift the focus of instruction from teacher to student by placing an emphasis on what as well as how students want to learn. This approach allows students to become active participants in their own learning and has been shown to increase learning, autonomy, and critical-thinking skills, as well as provide a more meaningful learning experience. Although there are many benefits to incorporating student-centered learning in a university or college setting, many instructors may not know how to move away from a more teacher-centered learning style. Here, I highlight how I have incorporated student-centered learning approaches in an undergraduate ecosystems course, both in lecture and lab settings as well as in assessments. By providing ways in which student-centered learning can be easily incorporated into a science classroom, as well as highlighting its benefits, I hope to inspire other instructors to employ this approach.

Student-centered learning is a progressive teaching approach that places an emphasis on what, why, and how students want to learn (Rogers, 1983). For example, students may be responsible for choosing what they will learn, their learning pace and style, and how they will assess their own learning (Crumly et al., 2014). Currently, most classroom instruction navigates under teacher-centered learning, where the teacher takes full responsibility for educating a group of students and students place all of their attention on the teacher. In this traditional approach, students remain quiet and listen as the teacher exercises full control of the classroom and activities. In contrast to teacher-centered learning methods, student-centered learning shifts the focus of instruction from teacher to student, allowing students to become active participants in their own learning process (Johnson, 2013). By prioritizing students’ interests first, student-centered learning has been shown to develop students’ autonomy, engagement, confidence, and critical-thinking skills and create a more meaningful learning experience (McCombs & Whistler, 1997; Jones, 2007; Young & Paterson, 2007).

In recent years, there has been an emphasis on moving away from teacher-centered learning toward student-centered learning within university and college settings (Cannon, 2000; Wright, 2011). Past research has shown that when employed, student-centered learning in higher education can promote learning and foster transferable skills, including critical thinking, reflecting thinking, and problem-solving (Attard et al., 2014; Hoidn, 2017).

Although there are several benefits to employing student-centered learning, many instructors may not know how to shift their approach from a more traditional teacher-centered learning style. It is therefore recommended to start slowly and incorporate aspects of student-centered learning into the curriculum. There are several ways to implement student-centered learning in an undergraduate classroom setting (Table 1). In this article, I highlight how I have applied some of these methods to enhance student-centered learning in my third-year undergraduate ecosystems course. I have incorporated this approach into several aspects of my teaching, spanning lectures and labs as well as assessments. By highlighting the different ways in which student-centered learning can be incorporated, I hope to highlight its benefits, as well as its easy implementation in undergraduate science classrooms.

Ecosystems course

At Saint Mary’s University, I instructed a semester-long, third-year ecosystems course that included both a lecture and a lab component. This course introduced students to basic principles of ecosystem ecology and focused on how ecosystems are being altered due to climate change and anthropogenic stressors.

This was a third-year, upper-level STEM course offered specifically for biology majors. However, students from other majors (including non-STEM majors) who had the required prerequisites (a second-year ecology
course) were also able to take this course as an elective. Having both STEM (majority) and non-STEM (minority) students participate in the course did not influence the use of student-centered learning as a pedagogical tool, as this approach focuses on how we teach, not what we teach.

The course included 23 students, with lectures and labs taking place in smaller rooms, fit for the class size. It is important to note that this smaller class size allowed more interactive opportunities with the students, facilitating the ease of some teaching-centered methodologies. For example, I was able to implement differential instruction in lecture and lab settings more easily. Differential instruction involves tailoring instruction to meet the needs of individuals and works best in small-group settings. Teachers instructing larger classes should adopt student-centered learning approaches that can be easily facilitated for their teaching environment (e.g., allowing students to communally vote on lecture topics or choose their own independent assignment topics; see Table 1 for other suggestions).

### Implementation of student-centered learning within lectures

This course consisted of 26 lectures. The first half of the course was structured around learning the basis of ecosystem ecology. This included lectures on primary and secondary productivity, trophic interactions, biogeochemical cycles, the earth’s climate system, and ecosystem change from climate change and anthropogenic stressors.

The lectures in the second half of the course were more open-ended. The aim was to synthesize the information gained during the lectures from the first half to look at specific ecosystems and issues. Because topics could vary considerably, this became an ideal place to incorporate student-centered learning. For example, I gave students the option to choose three “systems” to form the basis of three upcoming lectures. Their options included the following: marine systems, coastal systems, inland water systems, forest systems, dryland systems, island systems, mountain systems, polar systems, cultivated systems, and urban systems. Regardless of which three systems they chose, the premise of each lecture was to detail the specific ecosystem ecology of the chosen system (e.g., prominent trophic interactions, top threats from anthropogenic stressors, etc.). Letting students communally choose systems to cover enhanced their autonomy and created lecture material that interested them. I also left the last lecture of the course as an open-ended special topic and allowed the class to choose a topic near the end of the course. By the time they made their choice, they were well versed on the basics of ecosystem ecology and could choose an appropriate special topic issue. The class decided to end the course by looking at how individuals can impact ecosystem sustainability within their communities.

Although I designed and delivered all of the lectures, students actively participated in their own learning process by choosing what they wanted to study. To implement this approach, I created my lecture syllabus in a way that allowed for open-ended lectures during the second half of the course. I therefore encourage other teachers to a priori think about how their chosen

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tr>
<td>Some examples of student-centered learning that can be employed in lecture, lab, and assessments.</td>
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<table>
<thead>
<tr>
<th>Student-centered learning</th>
<th>Examples</th>
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</thead>
</table>
| **Lecture** | • Let students choose lecture topic (e.g., from a list of potential lectures).  
• Create discussions during lecture, and allow students to ask and answer questions relating to the material.  
• Let students present a lecture or a part of the section to the rest of the class.  
• Let students choose guest lecturers. |
| **Lab** | • Create long-term student-based lab projects (e.g., let students choose their topic, methodology, etc.).  
• Let students have a choice in their lab exercises (e.g., if teaching microscopy techniques, ask what they would want to observe, plant cell vs. animal cell, etc.).  
• Create lab exercises that are open-ended and use critical-thinking skills, instead of just following instructions and procedures.  
• Create lab exercises that are relevant and interesting to students (e.g., if teaching pipetting skills, let students bake a tiny cake using micro-pipettes). |
| **Assessment** | • Let students choose the topic for oral presentations, written reports, etc.  
• Let students choose between different forms of assessment (e.g., oral vs written).  
• Give options during tests so students can choose to answer on a topic that interests them (e.g., essay questions with several options).  
• Give students a grading rubric, and let them assess their own drafts (e.g., rubric for written reports). |
syllabus can help facilitate student-centered teaching approaches.

Overall, these lectures not only provided students with the essentials of ecosystem science but also were eventually tailored to their specific interests, allowing students to become more active participants in their own learning. Designing lectures based around students’ interests creates a more meaningful learning process and allows students to be more actively engaged in understanding and connecting to the knowledge being taught (McCombs & Whistler, 1997). This approach also lets students feel like they are co-creators in the teaching and learning process (Barr & Tagg, 1995). Past research has shown that motivation, learning, and self-confidence increase when students are treated as co-creators in the learning process (Aaronsohn, 1996; McCombs & Whistler, 1997). Taking this approach helped me in return, as I was able to teach topics that interested my audience.

**Implementation of student-centered learning within labs**

There were 11 lab sessions as part of the ecosystems course. Instead of implementing a set of lab exercises, chosen by me a priori to the class (teacher-centered learning), I decided to use this time to develop my students’ research and lab experience by focusing on their needs and intellectual desires. Students were placed in small groups (2–4 students per group) and given the opportunity to create an ecosystem-based research project that they could carry out within the timeframe of the course. They were able to choose a topic and whether to do a lab-based experiment, a greenhouse-based experiment, or an observational study. I worked with each group as they independently formulated their research question, conducted appropriate background research, and created their proposal. I provided them with the appropriate equipment required to carry out their data collection (e.g., seeds, soil, and pots for a greenhouse-based experiment looking at the combined effect of interspecies versus intraspecies competition on plant growth). Although I used one of our lab sessions to teach the basics of statistical analysis to the entire class, in subsequent labs, I guided each group in choosing and learning the specific statistical method required for their project. At the end of the lab, each group handed in a unique lab report that reflected their learning desires.

Letting students create and implement their own research projects drew on three essential elements of student-centered learning: individualization, interaction, and integration (Moffett & Wagner, 1992). Individualization allows students to create their own activities (e.g., creating their own research projects). Students then interact through team learning and by teaching each other (e.g., working with their groups to determine data collection, required to carry out their data collection, (e.g., seeds, soil, and pots for a greenhouse-based experiment looking at the combined effect of interspecies versus intraspecies competition on plant growth). Although I used one of our lab sessions to teach the basics of statistical analysis to the entire class, in subsequent labs, I guided each group in choosing and learning the specific statistical method required for their project. At the end of the lab, each group handed in a unique lab report that reflected their learning desires.

**TABLE 2**

**Course evaluation feedback from students.**

At the end of the course, students were asked to (anonymously) respond to the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Very poor (1)</th>
<th>Poor (2)</th>
<th>Average (3)</th>
<th>Good (4)</th>
<th>Very good (5)</th>
<th>Average rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>I found this course intellectually challenging and stimulating.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>4.5</td>
</tr>
<tr>
<td>I learned something which I consider valuable.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>33%</td>
<td>66.7%</td>
<td>4.7</td>
</tr>
<tr>
<td>My interest in the subject increased as a consequence of this course.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>41.7%</td>
<td>58.3%</td>
<td>4.6</td>
</tr>
<tr>
<td>Methods for evaluating student work were fair and appropriate.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>75%</td>
<td>25%</td>
<td>4.3</td>
</tr>
<tr>
<td>Students were encouraged to participate in class discussions.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>41.7%</td>
<td>58.3%</td>
<td>4.6</td>
</tr>
<tr>
<td>Students were invited to share their ideas and knowledge.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>4.5</td>
</tr>
<tr>
<td>Students were encouraged to ask questions and were given meaningful answers.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>41.7%</td>
<td>58.3%</td>
<td>4.4</td>
</tr>
<tr>
<td>Students were encouraged to express their own ideas and/or question the instructor.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>8.3%</td>
<td>41.7%</td>
<td>4.4</td>
</tr>
<tr>
<td>Compared to other courses I have taken at Saint Mary’s University, this course is:</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>41.7%</td>
<td>33.3%</td>
<td>4.1</td>
</tr>
<tr>
<td>Compared to other instructors I have had at Saint Mary’s University, this instructor is:</td>
<td>0%</td>
<td>0%</td>
<td>8.3%</td>
<td>33.3%</td>
<td>58.3%</td>
<td>4.5</td>
</tr>
</tbody>
</table>
analysis, and writing). During the learning process, students integrate what they have learned to construct new meaning (e.g., discuss in their writing report how their project relates to the broader literature and our understanding of ecosystem science).

This process also allowed me to implement differentiated instruction, one approach that can be used in student-centered learning (Gheyssens et al., 2020). When using differentiated instruction, the instructor moves away from whole-class instruction to small-group instruction and individual inquiry. This allows the instructor to teach material to students under a variety of instructional strategies, based on the needs of each student. By working with each group on their chosen projects, I was able to focus on topics that were of interest to my students, as well as accommodate a wider range of student needs and preferences (Algozzine & Anderson, 2007). For example, some students needed more help understanding how to set up a randomized experiment for their project, but others were able to grasp their methodological approach quickly and did not need additional support in this area.

Implementation of student-centered learning for classroom assessments

One of the assignments for the class was to create a 15-minute oral presentation. Each student selected a topic that interested them, independently conducted the necessary background information, and then taught the rest of the class, including myself, about their chosen topic. Topics ranged from mitigating food waste to the conservation of the Great Barrier Reef. This allowed students to specifically learn about what naturally fascinated them and gave them the opportunity to connect their topic to the concepts taught in the course. It was also a great way for the remainder of the class to learn about a wide range of ecosystem topics.

Another example of student-oriented learning was implemented during the final exam. The last section of the exam included a series of open-ended essay prompts:

1. Describe the impact of climate change on ecosystems. You can choose to focus on broad global patterns, a specific ecosystem, or a specific climate-related impact.
2. Describe the impact of anthropogenic stressors (e.g., nutrient pollution, overfishing) on ecosystems. You can choose to focus on broad global patterns, a specific ecosystem, or a specific anthropogenic stressor.
3. Describe a solution(s) for ecosystem sustainability. You can detail one solution or broadly focus on three.

This approach allowed students to tailor their answer to a topic that fascinated them the most during the course. Students wrote a range of detailed essays on topics such as the effect of over-fishing on coral reef ecosystems and the broad impact of climate change on ecological communities.

In both assessments, students were given the freedom to be assessed on a topic that interested them. Taking this approach allowed me to include the students in decisions about how their learning was assessed (McCombs & Whistler, 1997).

Concluding thoughts

In recent years, there has been an increased awareness of the benefits of student-centered learning (Cannon, 2000; Wright, 2011). To move toward this new model, instructors must be willing to emphasize learning while sharing power with students in the classroom (Barr & Tagg, 1995). Despite the benefits of student-centered learning, the challenge remains for instructors to be open to change and modify their teaching habits. I have provided some ways in which I was able to implement student-oriented learning under different contexts within an undergraduate ecosystems course. I hope this inspires other instructors to implement their own ways of incorporating student-centered learning into their classrooms.

The benefits of student-centered learning for students are clear and include increased autonomy, engagement, confidence, critical-thinking skills, and a more meaningful learning experience (McCombs & Whistler, 1997; Jones, 2007; Young & Paterson, 2007). I end by summarizing student reviews of their ecosystems course (Table 2), along with a few of their comments. This feedback offers further support for the idea that university courses emphasizing student-centered learning approaches can create an effective teaching environment for students.

Here are a few comments from students on their course evaluations:

"The lectures were easy to follow/listen to and I felt like I was learning in class instead of usually having to decipher confusing slides after class like I do in other courses. Initially, I did not want to take this class and was bummed I had to because of scheduling, BUT it turned out to be my favorite class and has made me start considering doing a masters in ecology."

"My interest in the subject greatly increased over the semester and I want to learn more about the field."

"Liked the (oral) presentations that everyone got to do that interested them. It makes presenting the topic easier and the presenter and the class actually care about the topic."

"Encouraged us to critically think."
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References


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