

Redesigning Dissection Lessons

Considerations for a Meaningful 21st Century Learning Experience

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Abstract: Dissection has become less common in the life science classroom as science educators have questioned what these experiences teach. Constructivist theorists of education have long suggested redefining the purpose of dissections to better fit the needs of student learning in the 21st century. Using the Next-Generation Science Standards framework, educators can create more meaningful dissections by incorporating opportunities for students to engage in true scientific inquiry. For dissection experiences to be worthwhile and meaningful for students, the activities must be carefully planned and worked into units where students can use such experiences to help answer central unit questions. Innovative 21st century dissection activities that allow students to engage in true scientific inquiry are addressed.

Introduction

For many years, dissections have been performed across a variety of grade levels in life science classes. Yet as the content standards in high school biology courses have increased, teachers have had less time to engage students in laboratory experiences such as dissections.

In addition, the value of dissection activities in the high school curriculum has been debated because of their potential to cause students anxiety and discomfort (Shine, 2014). This trend began in 1987, when a 15-year-old California student refused to participate in the dissection of a frog because she felt it was unethical. Because she did not participate, she failed the assignment. She then sued her school district because they did not provide her with a reasonable alternative assignment. As a result, California passed a law giving students the ability to opt out of dissection activities for moral reasons. Following this, schools across the country began implementing similar “opt out” policies. Some districts have chosen to remove dissections activities altogether (Shine, 2014). While some experts have suggested virtual lab experiences are beneficial for student learning (Shine, 2014), others suggest that the way dissections are taught rarely benefit student learning (Hug, 2005). Researchers agree that in order for dissections to continue to be taught, the goals and activity itself must adapt to the demands of a meaningful 21st century learning experience (Hug, 2005).

Laboratory Experiences Not All Created Equal

The Next-Generation Science Standards (NGSS) focus on the application and integration of the best practices of engaging in science using 21st century skills and technology. Using the NGSS, students engage in science in a fashion similar to that

of working scientists, promoting retention of concepts learned in class and a deeper understanding of science. Unfortunately, because Ohio's state biology science standards require teachers to cover an overwhelming amount of content in a year, teachers have had to reduce their quality of lessons, moving classroom work away from the NGSS goals. Note-taking and lecturing do not offer students opportunities to engage in true scientific inquiry. Educational researchers agree that active learning opportunities such as laboratory experience are most worthwhile for student learning (Hug, 2005; Solot & Arluke, 1997).

Active learning strategies can be defined as "instructional activities involving students in doing things and thinking about what they are doing" (Bonwell & Eison, 1991, p. 18). Active learning is rooted in the social cognitive theory and constructivist framework of education, and places less emphasis on the transmission of knowledge and more emphasis on the development of scientific processing skills (Wilke, 2003).

Active learning opportunities such as laboratory experiences offer students the opportunity to create hypotheses, develop experiments, make inferences, and draw conclusions. For example, Wallace (2003) designed a quasi-experiment where students took a questionnaire regarding the nature of science at the end of a semester. The results suggested that students had more significant gains to their knowledge base for designing an experiment after engaging in science labs that were inquiry-based. Because students were given an opportunity to engage in inquiry like a true scientist, they felt more connected to their learning. Passive learning practices such as note-taking and authoritative lab instructions do not give students the opportunity to put knowledge into practice, nor to synthesize ideas together creating a solution to a problem.

However, not all laboratory experiences have the same educational value. While Wallace (2003), argues that there is an educational benefit for students engaging in scientific inquiry during lab activities, there remains debate as to which kind of inquiry project is most beneficial. Sadeh (2011) has defined three types of inquiry: structured inquiry, guided inquiry, and open inquiry. In structured inquiry, students investigate teacher-formulated questions through prescribed procedures. During guided inquiry, students investigate teacher formulated questions and procedures and later determine the processes and conclusions. In open inquiry, the teacher defines the knowledge framework, but the students formulate a wide variety of inquiry questions to investigate. Incorporating inquiry experiences into the life science classroom can help students engage in more scientific discourse and help students better understand the nature of science as intended by the NGSS.

Using a Constructivist Framework to Reshape Student Thinking

One goal of dissection labs is to help students better understand the structural organization of various animal specimens. Unfortunately, most teachers do not give students time to address their concerns or allow them time to understand the purpose for performing a dissection. According to Solot and Arluke (1997), teachers must be aware that a majority of students will feel anxious when being presented with the task of completing their first dissection because up until that point, students have been taught to respect living organisms and not to disturb them. The anxiety and is-

issues students have with dissections begins with the idea of using instruments to cut open a once-living animal, because it seems contradictory to students' prior lessons on interacting with nature. Prior to performing a dissection, cutting open an animal to expose their internal structures would have been an inappropriate way to interact with the organism. According to Solot and Arluke, teachers must first spend time working with students to teach students that the dissection activity is meaningful and appropriate. Teachers need to give students time to understand the purpose of the lab and to grapple with their uncomfortable feelings rather than diving straight into a dissection lab. By spending time addressing student concerns, teachers can ensure that their students interact with them positively, and that they feel encouraged and excited about completing their work rather than feeling anxious or indifferent. Using Solot and Arluke's constructivist framework can teachers help prepare students mentally for the task of dissecting their first specimen.

Need for Alternative Assignments

Because so many students nowadays feel apprehensive about performing dissections, alternative assignments should be offered in place of a traditional dissection for those who choose not to take part in the dissection. Barr and Herzog (2000), investigated how students in a biology class felt after performing a fetal pig dissection and how their opinions changed overtime. They found that a majority of the students enjoyed the activity and believed the experience to be worthwhile, but every student also suggested that there should be an alternative option available to students.

Virtual dissections, allowing students to use computer programs to virtually dissect a variety of organisms, have gained popularity as a suggested alternative activity in place of dissection. Virtual dissections give students a reasonable opportunity to achieve the same learning goals as their peers performing a traditional dissection. There are many virtual dissection software tools available. Publishing companies such as McGraw Hill have virtual dissections that are available online for free. For example, the website URL http://www.mhhe.com/biosci/genbio/virtual_labs/BL_16/BL_16.html offers a virtual frog dissection. There are also supplemental handouts for teachers available for free download.

Researchers have examined whether or not virtual experiences are as educationally valuable as traditional dissections. For example, Predavec (2001) compared a traditional dissection to a virtual dissection of a rat. The students in this experiment were separated into a traditional dissection group and a virtual dissection group, each of which were asked to complete a multiple-choice quiz consisting of text-based questions, pictures and structures of dissection, and real dissected structures. The results suggested that students who were assigned to the virtual experience performed better on the multiple-choice quiz than those students who completed the traditional laboratory experience.

While it may seem strange that students in the virtual dissection performed better on their quiz than students who performed the traditional dissection, it's important to remember that this study took place in the early 2000s when such technology was just beginning to become popular. It's possible that students were fascinated by the computer programs and were more focused because they had the opportunity

to use technology they normally would not use. The results of Predavec's (2001) research is promising for teachers who may need alternative options for students who wish to opt out. If a student cannot participate in a traditional dissection, it's good news that the virtual dissections are able to help students achieve the same goals as their traditional dissection peers.

Improving Dissections to Meet 21st Century Learning Goals

Dissections have been performed for many years, but the activity itself has generally not been adapted to fit the needs of students as the goals in science education have shifted. Dissection activities as they exist now do not typically help students to develop skills in practicing or engaging in scientific inquiry. In order to meet the needs of learning in the 21st century, laboratory activities should be a space where students test scientific ideas and create hypotheses that can be adapted over time.

Hug (2005) has argued that one valid criticism regarding dissections is that they are typically procedural experiences rooted in tradition. Students are often given a procedure to follow in which students identify structures of a specimen. In traditional dissections, the students are not testing any scientific ideas; they already know the outcome and can anticipate the results. This type of passive dissection does little to help students develop a deeper understanding of animal anatomy. Often when a dissection lesson is planned, it is incorporated during a convenient time for teachers such as right before a break or when there is free time. This signals that the dissection is an extraneous activity rather than one central to the scientific work of the class.

Hug (2005) has suggested ways of recreating dissection activities to make the experiences more meaningful for students. These including creating dissection activities that are carefully planned to fit into a larger unit and that help students answer a central question. She embedded the dissection activity within the ecology unit of a high school biology class. The central question for the unit was "How do sea lamprey affect populations of yellow perch in the Great Lakes?" Throughout the unit, students learned about population dynamics and threats to certain ecosystems. Two dissection labs were incorporated into the unit, in which students compared the anatomical features of the sea lamprey and yellow perch. The lab helped students recognize why and how yellow perch were threatened by sea lamprey. Students felt more connected to the dissection activity because the activity helped them explore their unit's central question.

Recently, I created my own dissection activity that could be included in a high school biology class. This laboratory experience that could be embedded within the evolution unit of a high school biology course.

A teacher could begin a unit on evolution by introducing students to two very similar fish: the Atlantic Salmon and the Rainbow Trout. The unit would begin by introducing students to learn about each fish's environment and to describe the daily habits of each fish. Students would then spend a day comparing the exterior anatomy of each fish while the teacher asks guiding questions to help students make connections between evolutionary success and morphological adaptations (see <https://atlanticsalmontrust.org/salmon-and-sea-trout-facts/>). During the next two lessons, students would dissect each fish and compare their anatomical features.

Students might be able to see slight differences in muscle structure of each fish and to develop hypotheses linking the success of each fish in their environment to adaptations in their anatomy.

Dissection activities need not only involve animal specimens. Teachers should get creative with dissection activities and find ways to incorporate fungi or plant dissections as well. For example, when teaching units on plants, most teachers use an oversimplified model of flowering plant anatomy, which causes students to develop misconceptions (McIntosh & Richter, 2007). Teachers can help address such misconceptions by having students complete a flower dissection activity and comparing monocot and dicot flowers. Students could begin by first dissecting and comparing monocot and dicot seeds and identifying a monocot's single cotyledon and a dicot's two cotyledons. Students would then be able to identify monocots and dicots in nature.

Conclusion

The demands of the 21st century have inspired teachers to reconsider the way dissections are taught in their classes. Hug (2005) suggests dissections have the potential to address student misconceptions and serve as powerful opportunities for students to think in creative ways. However, dissections are often poorly delivered in the classroom and therefore provide little benefit to student learning. In order to use dissections more effectively, teachers need to address the purpose of performing a dissection, to plan when to incorporate the activity into a larger unit, and to ensure that the activity will help students address questions from the larger unit they are learning. Incorporating dissection activities into a larger unit of learning can help students recognize the purpose of those dissections and see how these activities will help them better understand content from the larger unit. By reframing how they lead dissections, educators can help students engage in scientific inquiry in ways that improve on the methods of the past.

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About the Author

Amanda Mager holds a bachelor's degree in integrated science education and a master's degree in biology education. Her philosophy is to foster relationships first so students can have a meaningful experience, becoming lifelong learners of science.