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Three Barriers Obstructing Mainstreaming Alternatives in K-12 Education

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Summary
The limited use of alternatives in secondary education contrasts with the concerted adoption of alternatives in veterinary curricula. Taking a teacher's perspective, three barriers obstruct mainstreaming of alternatives in high school biology courses. First, dissection is not addressed in course outlines, curricular standards, and frameworks. Second, financial and technical support for resources in science teaching is lacking. Third, teachers need ways to motivate their students to learn biology and offer them stimulating, informative materials. Preparation of appropriate materials for five to ten biology laboratories could address these three barriers at modest cost and effectively deliver biology to secondary students.

Keywords: biology, secondary education, dissection, teaching, alternatives, intermediate education, physiology, systems

Introduction

Using dissection or experimentation with animals as a method of teaching students has a colorful and contentious history (Tansey, 1998; Klestinec, 2004). Ideas in science education have evolved through the nineteenth and twentieth centuries (DeBoer, 1991), yet the use of animals in laboratories of secondary schools in the United States has continued with little change or educational scrutiny.

Considering the uses of animals in research, teaching, and testing, the uses in education seem most amenable to replacement, the most sought after of the 3Rs. Indeed, veterinary schools increasingly have mainstreamed alternatives in their curricula and a large number of teaching resources are available (Hart et al., 2005), but widespread adoption of alternatives has not yet occurred for teaching high school biology in the United States. Monitoring the use of animals in education, while not a comprehensive effort, indicates there has been a sharp reduction of animal use in higher, medical, and veterinary medical education, but perhaps less reduction at the secondary level. Having a substantial replacement of animal use in the advanced education and training of veterinarians, but still using many animal specimens in high school teaching, looms as a growing paradox that continues as a subject of criticism and controversy.

Consistent with the adoption of alternatives in higher education, an ever-growing supply of resources exist, almost 4,000, that are cataloged in the NORINA database (Smith, 2005). Some of these resources are categorised and described in the InterNICHE book and website (Jukes and Chiuia, 2003; InterNICHE, 2005), as well as the AVAR website (AVAR, 2005). Both traditional and alternative resources, including dissection materials and various models, are advertised widely by distributors (Carolina Biological Supply Company, 2005; NASCO Online Catalogs, 2005). Despite this great number of resources, secondary school teachers still are not offered and provided a well-integrated package of resources that interface with and complement the curricular lessons for courses in high school biology and physiology.

Over the years, papers and books concerning opposition to use of animals in education have presented relevant analyses, including reviews of ethical considerations for alternatives (Langley, 1991), and the patterns of use in the United States (Orlans, 1991), in other countries (Balcombe 2000a), and in higher education (Balcombe 2000b). Reflecting the controversial nature of the topic, in some papers, the posture has been frankly political or philosophical, arguing that we should or should not allow dissection (Sapontzis, 1995; Kline, 1995). Much of the controversy concerning animal use in secondary education has focused directly on communication with students, providing legislated protection to those who prefer to use alternatives and coaching them in strategies to avoid dissection (Balcombe, 1997a). Another topic, again focusing on students, has been considering the adverse ethical consequences of instructing students to be involved in harming or killing animals (Orlans, 2000).

A study from England reported on a survey of 468 students regarding their experiences with and attitudes toward animals in education, including dissection (Lock and Millett, 1992). A subsequent survey assessed the use of animals from the teacher's perspective (Adkins and Lock, 1994). About a third of the teachers held opinions that discouraged them from using animals in their teaching. In an Australian study, all 34 surveyed schools reported doing dissection, limited primarily by cost, and almost all schools also included activities with living animals (Smith, 1994). A retrospective study in Canada sought to document students' experiences and attitudes, both positive and negative, concerning dissections they performed in secondary school (Bowd, 1993). Lock (1994) replied, agreeing with many aspects of Bowd's paper, but differed in having the view that no alternatives were superior to dissection. An ethnographic study was conducted later to learn more about the reactions of students to their experiences in dissection (Barr and Herzog, 2000). Like Bowd, they found that a substantial minority viewed dissection primarily in negative terms.

Comparing the performance and achievement of high school biology students who use simulated dissection versus actual dissection, the simulation was equally effective for learning (Kinzie et al., 1993). A review of various studies using simulated alternatives for teaching anatomy, at various academic levels, also found that simulations yielded similar achievement outcomes as live dissection, whether using low-tech or high-tech simulations (Zirkel and Zirkel, 1997). Yet another approach has been to use the simulation as a preparation for the dissection, resulting in the students learning more anatomy following the dissection (Akpan and Andre, 2000). In general, the issue of dissection appears to have been most visible during the late 1980s and early 1990s, then giving way in the educational community to emphases on standards, curricula assessment, and diversity. Dissection is strikingly absent from published materials on standards and frameworks.

With these laboratories, there may be a gap between the objectives set for the laboratory and the accomplished outcomes associated with the expected learning (Ralph, 1996). A recent assessment of laboratories in U.S. high school science curricula by the National Research Council has concluded that, in general, the quality of current laboratory experiences is poor for most students, and that improving high school science teachers' capacity to lead laboratory experiences effectively is critical (Singer et al., 2005). Additional criticism was leveled at the organisation and structure of most high schools, the state science standards, and the current large-scale assessments. Similar criticisms were reported from an earlier study of the laboratory work in British Columbia High Schools, a report that called for substantial research and reform (Gardiner and Farragher, 1999).

These varied perspectives have not considered the constraints teachers face, but rather have criticised teachers. Balcombe (1997b) evaluated some of the barriers against acceptance of alternatives in teaching, including that some teachers are resistant to change; it requires investing time and money; information on alternatives is not widely disseminated; and the quality of material available varies. In more recent writings Balcombe (2001) has directly made a case for adoption of alternatives rather than using dissection. In this presentation, we build on the paper by Balcombe (1997b) concerning the barriers against acceptance of alternatives. Taking the teachers' perspective, we propose three barriers mitigating against rapid adoption of alternatives in classrooms, recommending production of web-based teaching resources to address these barriers and improve instruction in biology laboratories, especially within the United States.

Methods

Two groups of pre-college teachers participated in discussions that contributed to this paper. A group of 23 teachers worked with us during the academic year, 1993-1994, using instructional software, "The Virtual Heart", in their classrooms (Zasloff and Hart, 1997). During 2003-2004, 5 teachers participated in a focus group and subsequently continued as consultants in further discussions. The teachers all were teaching in public junior or senior high schools in the Sacramento Valley during the period of their participation.

Barriers against Adoption of Alternatives

Teachers generally are highly motivated to employ the best teaching materials and resources they can feasibly acquire, often even purchasing materials with their own funds. Although the topics of biology that lend themselves to dissection are interesting to students, the curriculum is very full with information required to be taught, leaving little laboratory time for most teachers when teaching mammalian biology. Commonly, about five laboratory sessions are scheduled, sometimes as double periods. Occasionally, a semester-long physiology course is offered, permitting more extensive laboratory experience for the students. In these contexts, teachers typically offer some type of dissection experience, though faced with the three barriers described below.

1. Dissection not addressed in curricular materials and frameworks

A curricular gap exists. Though traditional and common within intermediate and secondary school biology classrooms, the practice of dissection is seldom mentioned within science education research, national curricular standards, and science frameworks. It has not had prominence in the past decade as a topic of importance. It does not appear in course outlines, and no major dialog concerning science curricula includes a consideration of dissection. Thus, there is no prominent platform where teachers and educational professors discuss methods for presenting laboratories involving dissections or alternatives. Teachers need to figure out for themselves how to structure these laboratories in their classrooms.

2. Phase-out of teaching resource centers

Instrumental and technical supportive resources for science laboratories have been sharply reduced across recent decades. County educational districts formerly provided resource materials that were integrated with specified laboratories for lesson plans and supported by specialists providing assistance with subject matter. These centers providing teaching resources have been dismantled. Teachers are on their own to acquire and accumulate teaching materials when needed to enhance their courses. The small budgets that are provided are only sufficient for purchasing a few clerical supplies. Abundant resources are available commercially, but they are costly and not presented as an integrated set of resources for high school biology (Weng et al., 2004a, 2004b). A few resources are available on loan, for example from Animalearn (2005) or the Humane Society of the United States (2005), but this requires planning well ahead and scheduling for particular lesson plans. The gap in the curricula and resources for science laboratories sets a stage for the third barrier.

3. Teachers' goal to motivate and interest students

To teachers, supplying motivating and informative materials for students in classrooms is of prime importance. Teachers enter the profession dreaming of motivating students to learn, but are hampered in achieving their dream. They seek to inspire their students. In high school biology, a worthwhile laboratory exercise that would mark a quality experience for students is difficult for teachers to muster. Whether to use animal specimens and other resources in high school classrooms is not considered within the texts of curricular standards and science frameworks, nor are such resources and relevant expertise offered by school districts. Thus, the teachers' highest goal of inspiring their students in biology becomes ever more unattainable. A common question from teachers is, "How can we engage them?"

Solution to Adoption of Alternatives

The curricular requirements for teaching some laboratories in high school biology are relatively simple and straightforward, and could improve basic education in biology for students across the United States. In crafting a solution, it is critical to recognise that teachers have limited time available for laboratories on these topics; the resources required to meet their needs are not great. Even five outstanding laboratories produced in software and made freely available on the web could revolutionize biology laboratories in many classrooms. As a start, appealing software on the virtual mammal covering five basic laboratories on the skeletal-muscular, respiratory, digestive, nervous, and circulatory systems would provide a solid basis of education. With additional resources, the urinary, lymphatic and immune, skin, and endocrine systems could be added, plus organs such as the heart, brain, lungs, kidney, eyes, and ears, and joints such as the knee, hand, and foot, addressing the major needs of high school teachers. The teachers could complement these materials with other resources that they acquire.

Considering the number of students who could benefit from these improved teaching resources, the cost of preparing such software would be small. One possibility could be an increased commitment to this objective by animal advocacy groups (Fleischmann, 2003).

Conclusions

Teachers of high school biology often retain the traditional pattern of offering dissection of an animal. They seek new and improved resources, and consider using those that are easily accessible. But they are provided almost no budget for their laboratories, so are left to improvise and scavenge when designing the laboratories they offer. The disappearance of resource centers from school districts isolates teachers as they approach this quandary. The overriding motivation of teachers is to stimulate their students to enjoy learning. Dissection remains a favored avenue for providing an engaging experience to students. Production of five to ten outstanding software units on basic physiological systems could establish a solid foundation for secondary school biology laboratories everywhere.

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