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Biology Education in the U.S.A: Recommendations for These Similar Problems in Turkey

ABD' de Biyoloji Eğitimi: Türkiye'de Benzer Sorunlar İçin Öneriler

Özgür Taşkın
Indiana University

Abstract

It is known that biology education has been ignored from many aspects. However the reasons and results of this underestimation is still being discussed. The aim of this article is to provide an account of current application faults of new instructional approaches in the U.S.A. and to eliminate misunderstandings of these terminologies. The present study stresses the importance of the multidisciplinary dimensions of biology education and sheds light on the existing or possible problems that Turkish education system might face.

Key Words: Biology education, science education, learning theories, alternative conceptions.

Öz

Biyoloji eğitiminin birçok yönleri ile göz ardı edildiği bilinmekte, fakat bunun nedenleri ve sonuçları hâlâ tartışılmaktadır. Bu derlemenin amacı ABD'de uygulanmakta olan yeni öğretim yaklaşımlarının uygulanış yanlışlarını ortaya koymak ve buna bağlı terminoloji karmaşıklığını gidermektir. Çalışma, biyoloji eğitiminin çok disiplinli yönünün önemini vurgulamakta ve Türk eğitim sisteminde ortaya çıkabilecek veya var olan sorunlara ışık tutmaktadır.

Anahtar Sözcükler: Biyoloji eğitimi, bilim eğitimi, öğrenme teorileri, alternatif algılama.

Introduction

As Francis Bacon, "father of experimental science" mentioned, "the ill and unfit choice of words wonderfully obstructs the understanding." The number of studies focusing on teachers' understanding of scientific concepts has grown significantly though chemistry, biology, and physics can still create some problems for teachers (Lawrenz, 1986). As seen, misconceptions are problems not only for students but also for teachers. These misconceptions can emerge from either student's life experience or lack of conceptual knowledge that was given in classes. In addition, the memorizing process in an education system also leads to misconceptions.

These misconceptions cannot be corrected easily by using modern technologies in schools or sophisticated and demanding learning theories such as pure constructivism or behaviorism.

Even though the U.S. Government has spent much more money than other countries on revising and improving the education system for many years, the results are not as great as many have thought. For instance, although financial support for science education in Hungary and Czech Republic have been much lower than that of the U.S., performance assessment results show that in these two countries, students are more successful than that of the U.S. (http://www.economist.com). Where does the problem emerge? In terms of science education content, particularly in biology education, should some issues be revised? Is it possible to handle all problems by a revision of the curriculum? Is the conceptual knowledge of science teachers adequate in their field?

Can shortcomings in biology education be revised without out-of-field biology teachers?

Problems

So far, both my perceptions and research results show that biology, particularly the study of plants in biology classes, has been ignored at all class levels in the U.S. As Reinsvold (1999) stated " In high school, based on

Özgür Taşkın, Ph.D. Indiana University, School of Education, Science and Environmental Education Department. Bloomington, IN., U.S.A. otaskin@indiana.edu

teacher surveys and best-selling textbook examination, teachers use plants as an example organism less than 20% of the time". Perceived feelings and thoughts of students about biology class in the U.S are based on "animal and human". As Hershey (1993) stated biology generally is perceived as zoology or physiology. So, the botany has been ignored; that is maybe why the main misconceptions in biology issues have emerged from botany issues. A good example of this is popular belief among students that plants take nutrients from the soil. But this misconception does not belong just to students. Science teachers in schools have also similar misconceptions. Another misconception is related to respiration mechanisms of both plants and animals. In this context, animals can breathe and plants can photosynthesize. Although many issues in biology classes are more concrete than those of chemistry and physics (Shekan and Nelson, 1997), why do misconceptions in terms of science education occur in biology classes?

At first glance, relationships among scienctific disciplines have been ignored for many years in the U.S. For instance, in order to give a lecture about transportation systems in plants, in-service science teachers in elementary schools must know fundamentals of physics and chemistry. But, even beyond knowing, they should have critical thinking and conclusion abilities. While giving descriptions of water and nutrient transportation in plants, teachers will probably face some other issues related to chemistry and physics such as adhesion, cohesion, surface tension, negative pressure (vacuum), and so forth. Consequently, problems regarding biology classes should not be evaluated simply on the basis of conceptual knowledge of teachers about biology. As Mahner and Bunge (1996) claimed, "if science constitutes a system every subsystem of which (biology, physics, social science, chemistry) is tightly connected to some other discipline then it is not science". Similarly, Tinker (1996) stressed that multidisciplinary curriculums will enable science educators to reach success in science classes.

The second issue is that of the content of biology textbooks and the curriculum period. Although the books are colorful and attractive for students, the curriculum period is very rushed (i.e. a lot of material covered in a short amount of time). Aldridge (1992, 1-8) said that even though biology classes are 540 hours at the elementary level in a year in the U.S., total hours in biology classes in 5 years in the C.I.S. (Commonwealt Independent States- Former Soviet Union) are 110 hours. China has a similar approach to that of the C.I.S Although the biology curriculum in the U.S. seems mor sophisticated and dense than those of other countries because of the rushed class period in a year, students ar not able to maintain a connection between biology issue and other multidisciplinary science branches. As a resul the most important problem in science education is ar "unwillingness toward and fear of science class". I order to deal with these problems in science educatior particularly in biology education, the distribution of tim spent in biology classes in a year must be appropriate t the material covered in a year (Aldridge, 1992, 9-19) For instance, half hour science classes in schools must b reorganized and lengthened.

Another issue is that available experiments that can b implemented easily in biology classes are being ignored These experiments are appropriate in terms of bot safety of children and affordable for all children (Sal 1990). Although there is discussion about ethics i science classes, it will not be an issue if plants are th major material in biology class.

A controversial issue is that learning theories will b sufficient to solve the problems that occur in biolog classes. Constructivism is the most popular learnin theory nowadays. According to this theory, student have the ability to construct anything using their real lif experiences. This sounds persuasive, but perhaps som issues are being overlooked: well-educated scienc teachers and school facilities. As pointed out in th Glenn Report (http://www.ed.gov) many teachers i science education area are out-of-field. Hov constructivism will sustain the development o children's abilities and creative skills is not clear Without well-educated science teachers and good schoc facilities, constructivism cannot work properly particularly in public schools because of lack o equipment. Unfortunately, "enjoyable and funn classes" cannot help both students and teachers improv themselves and focus on biology. Instead of polarizatio such as modern and traditional education, the bes workable parts of models and theories can co-exis together (Hirsch, 1996). To sum up, in order to ge significant achievement in science education, all theorie can be applied in the appropriate place and time.

Being just interested in learning theories without pur science and applied science inhibits the creative abilitie

and the intellectual level of teachers. A lack of conceptual knowledge can be observed not only in in-service teachers but also in pre-service teachers (Ratcliffe, 1999). Being a teacher involves life long learning. That is why in-service teachers should attend training annually (Wandersee et al., 1994). So teachers' performance must be evaluated and qualified without bias. Consequently, science educators will have greater confidence in their professionalism, have more self-esteem and gain a stronger reputation than before. Therefore teachers can be certified, and schools can have more qualified science teachers.

It is certain that reforms in terms of biology education have improved achievement in science education in the U.S. For instance, The Scope, Sequence, and Coordination (supported by the National Science Teachers Association), Project 2061, The State-Wide Systemic Initiatives (supported by the National Science Fund) and so forth are examples of reform attempts. To tell the truth, it is not possible to say that all reforms regarding science education are always successful programs. As Confrey (2000) claims, science education needs more holistic and systemic reform. Reforms are generally at elementary and middle school level. On the other hand reforms at the undergraduate level of education are forgotten (Penick, 1995). Unfortunately, I recognize that memorization is still the most important part of undergraduate education instead of inquiry. It is certain that, to change the current situation regarding support and the professional development of science teachers, they should be motivated to embrace more inquiry and critical thinking activities in their courses instead of rote memorization.

The last point that needs to be stressed is that of the controversial issues in biology education such as the theory of evolution. "Teaching evolution presents special challenges to the science teacher." In order to deal with this problem, biology teachers can work together (National Academy of Sciences, 1998). Appropriate strategies should be improved to overcome such difficulties in the biology class. For instance, although the Theory of Darwin is stronger than Newton's Theory, many discussions occur between parents and school administration because of the style of presentation of Darwin's Theory, particularly in conservative states. Furthermore both pre-service and in-service science teachers should realize that the term "theory" does not mean hunch or simple guess in scientific terms (National Academy of Sciences, 1998; Skehan and Nelson, 1997). The American National Science Academy has also stressed over and over again that biology teachers must not ignore this issue.

Conclusion

Although it is not possible to solve all the problems in biology education in the immediate future, certain steps and encouragements will help move it forward. These are as follows:

1) Inquiry-based science education should be regarded as a new approach while reorganizing the new science curriculum. The main goal is to support life long inquirers (students) for our country.
2) Science teachers who give biology lectures should have adequate conceptual knowledge and intellectual abilities, and they should use these capabilities creatively.
3) Learning theories must be overlapped in science classes depending upon time limitations and school facilities. In order to avoid disagreement about learning theories such as constructivism, behaviorism and so forth, teachers must have a working knowledge of multiple learning theories. At the very least the teachers must know that constructivism does not mean just to "construct" and thereby avoid all responsibility as educators in science classes. On the contrary, science teachers who are really interested in this particular learning theory must have a intellectual and creative ability strong enough to promote a better understanding of biology.
4) The relationship between biology and other science disciplines must be established (physics, chemistry, environment and nature science etc.).
5) In the curriculum, botany must not be ignored. The dynamics and diversities of plants must be introduced to students.
6) In the first 5 years of elementary school, professional biology teachers must teach biology classes (certified, not out-of-field teachers).
7) The Secretary of National Education, universities, and research institutes must prepare programs and courses in order to reeducate in-service teachers. These courses must embrace pure science, learning theories, and instructional technologies in terms of innovation.

8) Textbooks must include experiments (hands-on activities) that can be applied in biology classes effectively. Furthermore, these experiments must help students make clear connections between all issues in biology classes.. Most importantly, the materials used in experiments must be affordable.
9) Instead of just presenting issues to students, methods as critical thinking, cooperative learning and minds-on activities must be employed in biology classes.
10) Science classes must be distributed properly over the year (i.e. timing limitation for science classes).
11) Issues such as the theory of evolution, genital organs, genetics etc. must not be ignored in science class curriculum.
12) Visual and audiovisual instructional equipment must be part of education. However, this equipment should just be used in order to clarify abstract issues-not to replace instructors in classes.
13) The Internet must be used effectively. Teachers must be aware of which websites are appropriate or not. Teachers must not recommend websites prepared by out-of-field people to their students.
14) Both in elementary and secondary education, biology issues must be supplemented by wall charts (Westhead, 1998). These issues, particularly environmental and geological issues related to biology classes, must be supported by field trips if possible.
15) No matter what students ask of teachers, they must try to give answers. If teachers don't have have enough conceptual knowledge, they must learn how to access databasse in order to respond to students' questions.
16) The connections among the administrations, teachers, parents, and school boards must be strong enough to solve problems that occur locally. These relationships must also be extended to schools and local businesses in order to provide schools equipment.

Consequently, the most important issue is to understand the shortcomings in science education. In order to deal with these problems, the polarization between educators must be eliminated. I do not suggest that the teachers are completely inadequate nor do I mean that these problems are unsolvable. Rather, I have tried to take illustration from biology classes in order to show what is happening in biology classes.

Although these problems belong to the U.S.A.'s education system, as Okçabol and Gök (1998) stated, 58% of teachers confess that the Turkish education system is based on memorization instead of inquiry-based learning. Without doubt, the perceptions outlined in this article will help people interested in science education recognize and solve possible problems in the future of Turkey.

To sum up, science education in the U.S.A. has serious problems. The problems are concrete, but the solutions are abstract. However I am sure that American science educators' experiences will help their Turkish colleagues reach better solutions in Turkey. We need more vertical communication between universities and elementary, middle, and high schools in Turkey. Furthermore, we, as universities, science teachers, need to converge in terms of revisions of science curriculum based on inquiry urgently. If we are really willing to live in a contemporary age of a knowledge-intensive society (instead of a society that only believes it is contemporary), then we should be ready for radical revisions together.

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