JOURNAL OF MICROBIOLOGY & BIOLOGY EDUCATION, May 2015, p. 3-4
DOI: http://dx.doi.org/10.1128/jmbe.v16i1.801

Letter to the Editor

To the Editor,

Education is rapidly changing, with the focus largely placed on diverse teaching methods that seek to improve students' engagement and understanding, and also address specific learning goals. For this reason, concerned authorities throughout the world are paying close attention and devoting resources to education, especially science, technology, engineering, and mathematics (STEM) education. Thus, efforts that can improve STEM education are to be upheld. Biology is one area of STEM that continues to play important roles in helping us know more about ourselves and our environments. Unfortunately, there is a vast disparity in biology education between scientifically advanced countries and many developing countries. One issue that is usually blamed for the poor scientific culture in the developing world is the lack of contemporary laboratory resources to support the introduction of modern experiments (5, 6, 8). While several initiatives have been rolled out (such as strengthening laboratory education in resource-limited settings through the provision of remedial interventions (5)) or proposed (including the development of laboratory equipment maintenance policies (4)) to help address this situation, I share the view that alternative innovative approaches are also needed: for instance, strategies that will integrate modern techniques, such as advances in information technology, with biology. An article published in the December 2013 edition of the *Journal of Microbiology & Biology Education* (3) provides evidence of the potential effectiveness of this approach. In the article, the author reported on the incorporation of game design elements into microbiology experiments to help increase student engagement by structuring the experiments into coherent, easy-to-follow units. Specifically, the article suggested that the incorporation of computer games would be a viable way of improving biology education, by positively influencing learner engagement and understanding.

As an educator in the developing world who is seeking to improve my teaching experience and student outcomes, I find this paper useful in many ways. I make the following inferences from the article:

1. Not only a fully functional "wet" laboratory can support student engagement and learning in biology. Although several areas of biology (such as microbiology and biochemistry) have traditionally been largely focused on wet laboratory experimentation, there is the need for educators to appreciate that other disciplines (for example, computer science) can make important contributions to the advancement of biology education.
2. In the absence of a functional biology laboratory, other innovative approaches can be used to impart knowledge to students. Although the author combined the wet laboratory and the "gamified" aspects of the microbiology course, I believe the gamified exercise can be taught independently. For example, Cheng and Annetta (1) used video game elements to teach students about the negative impacts of the psychostimulant methamphetamine on the brain. It was found that students' attitudes toward methamphetamine use became significantly more negative after being exposed to the game.
3. Interdisciplinary approaches can be important in enhancing student training. Computer science is one field that has contributed to improving biology education and research in recent times. The development of computational biology, bioinformatics, systems biology, and their related scientific disciplines demonstrates that interdisciplinarity is vital when it comes to biology (2, 7).
4. In any educational institution, working closely with the computer science department can be beneficial to the biology department. The two can work together to develop tools and methods to enhance the use of computational approaches in teaching biology. This would be particularly useful in resource-limited countries because it is usually cheaper to operate a computer laboratory than a wet biology laboratory (2). As access to the Internet continues to improve in the developing world, many developing countries have also made considerable investments in computer science-related disciplines, examples of which can be found in sub-Saharan Africa (7). These developments help to enhance access to useful educational resources including open-source software. Furthermore, many educational games can be used "offline" without the need for a constant Internet connection, suggesting that such games can be implemented in areas where access to the Internet is either unreliable or does not exist. These advantages make the adoption of innovative computational approaches in biology education an attractive venture in many parts of the developing

world, especially rural areas. This synergy can also provide a double-pronged approach: training biology students on one hand to use computer gaming technology, while on the other hand giving computer science students the opportunity to improve their understanding of biology.

5. Game design can help impart applied knowledge to students. This is exemplified by the game elements in Dr. Drace's article (3), which allowed the incorporation of aspects of applied microbiology such as water purification, food fermentation, and biofuel production.
6. Cross-disciplinary skills can be incorporated in laboratory exercises with game objectives. For instance, the cause of the disease outbreak in the gamification exercise (3) was provided as a genetic sequence that had to be translated into a peptide to provide clues about the pathogen; this allowed the integration of molecular biology techniques into the microbiology course. Moreover, through the presentation of their findings after the course, students were given the opportunity to master several important transferrable skills such as presentation skills, argumentation skills, confidence building, and public speaking.
7. Alternative forms of assessment. The game reported in the article was designed in such a way that advancing from one step to the other required learners to have excelled in the previous stage. The immediate feedback such a game provides is a good formative assessment, allowing users to improve their performance in order to reach their goals. This type of assessment might be useful to both students and instructors.
8. As an extension of Dr. Drace's article (3), I reason that game elements can be incorporated into many existing laboratory syllabi for several areas of STEM education to help improve learner engagement and performance, especially in the developing world, where useful-yet-simple educational interventions are urgently needed.

In conclusion, integrating innovative interventions such as game design with biology has the potential to help improve learning outcomes in biology education. Gamification, in particular, could be a real path to bringing advancement in biology education to developing countries.

Sincerely,

Thomas K. Karikari
Department of Science Laboratory Technology
School of Applied Science and Technology
Wa Polytechnic
Wa, Ghana
E-mail: ohenekakari@gmail.com

REFERENCES

1. **Cheng, M.-T., and L. Annetta.** 2012. Students' learning outcomes and learning experiences through playing a serious educational game. J. Biol. Educ. **46:**203–213.
2. **Counsell, D.** 2003. A review of bioinformatics education in the UK. Brief Bioinform. **4:**7–21.
3. **Drace, K.** 2013. Gamification of the laboratory experience to encourage student engagement. J. Microbiol. Biol. Educ. **14**(2)**:**273–274.
4. **Fonjungo, P. N., et al.** 2012. Laboratory equipment maintenance: a critical bottleneck for strengthening health systems in sub-Saharan Africa? J. Public Health Policy **33**:34–45.
5. **Fonjungo, P. N., et al.** 2013. Preservice laboratory education strengthening enhances sustainable laboratory workforce in Ethiopia. Human Res. Health **11:**56.
6. **Sofola, S.** 2014. Challenges of teaching and researching physiology in sub-Saharan Africa. Physiology (Bethesda) **29:**150–152.
7. **Tastan Bishop, Ö., et al.** 2014. Bioinformatics education—perspectives and challenges out of Africa. Brief Bioinform. **pii:**bbu022.
8. **Yusuf, S., T. Baden, and L. L. Prieto-Godino.** 2013. Bridging the gap: establishing the necessary infrastructure and knowledge for teaching and research in neuroscience in Africa. Metab. Brain. Dis. **29**(2)**:**217–220.