

Emerging Issues: Open Educational Resources How Science Teachers Can Use Open Educational Resources to Revitalize Lessons

STEM literacy has a profound and growing impact on our day-to-day lives. It helps us make critical decisions about our health care, our finances and our retirement. It illuminates the ever more complex issues that govern the future of our democracy, and it reveals to us the beauty and power of the world we inhabit. A literate nation not only reads. It computes, investigates and innovates.

Change the Equation¹

Projections show that 80% of jobs created in the next decade will require some form of STEM expertise and that STEM workers will earn higher wages—26% more than non-STEM jobs.² Data from the Center on Education and the Workforce at Georgetown University predicts that job growth will continue at a rapid rate in STEM-related fields such as health care, information technology, and natural resources management³, fields that require creative problem solving and critical thinking about complex problems.

To develop such a workforce, the Partnership for 21st Century Skills⁴, whose members include such companies as Microsoft, Apple, and Cisco, has

called for a greater focus on the development of such 21st century skills as critical thinking, problem solving, creativity, and communication – in other words, computing, investigating, and innovating. These skills are necessary not only for upper-level managerial jobs, but also for entry-level jobs that do not require a college degree.⁵

But how can we expect a workforce that computes, investigates and innovates without building these skills into our education system? As is often the case, it falls to our K-16 education continuum “to respond to our country’s need to develop a strong STEM pipeline and workforce and to inspire and influence U.S. students to pursue and persist in STEM-related careers.”⁶ This isn’t a new challenge. But what might be a new twist for invigorating curriculum planning and lesson development is embedding open educational resources (OERs) in existing coursework to more readily engage students in the creative thinking and problem solving required of a STEM-literate workforce.

What Are Open Educational Resources

We would like to set aside the idea and practice of searching for classroom

lessons on the Internet, and instead introduce readers to what may be a new term – Open Educational Resources (OERs). The term was first coined by UNESCO in 2005 and refers to “teaching, learning or research materials that are in the public domain or released with an intellectual property license that allows for free use, adaptation, and/or distribution.”⁷ The availability of these types of materials links effortlessly to the U.S National Education Technology Plan of 2010⁸ which challenges educators to explore how technology can build “the capacity of our education system to deliver effective teaching...by enabling a shift to a new model of connected teaching” in which students are more fully engaged in their learning experiences.

OERs offer educators what might be termed ‘value neutral’ online resources which the end users can embed in customized lessons for their students – lessons that depend solely on the innovation of the teacher, the needs of the students, and the local or state standards required. Using OERs requires an investment of time and creative thinking in order to develop engaging and technology-supported lessons for students, but the reward is that lesson development lands back in the hands of teachers.

Interest in STEM Careers. Arlington, VA: National Science Teachers Association.

⁷ UNESCO: <http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-educational-resources/>

⁸ U.S. Department of Education (2010). National Education Technology Plan. *Transforming American Education: Learning Powered by Technology.* Available at <http://www.ed.gov/technology/netp-2010>.

¹ <http://changetheequation.org/why-stem>

² <http://www.esa.doc.gov/Reports/stem-good-jobs-now-and-future>.

³ Carnevale, A., Smith, N., & Strohl, J. (2010). Help wanted: Projections of jobs and education requirements through 2018. Washington, DC: Center on Education and the Workforce, Georgetown University.

⁴ Schwartz, R. B., Ferguson, R., & Symonds, W. C. (2011). Pathways to prosperity: Meeting

the challenge of preparing Americans for the 21st Century. Cambridge, MA: Pathways to Prosperity Project, Harvard Graduate School of Education

⁵ Education Week, March 26, 2008.

⁶ Wojnowski, B., Charles, K., & Warnock, T.G. (2012). Why STEM? Why Now? The Challenge for U.S. Education to Promote STEM Careers (Chapter 5). In Yager, R.E. (Ed.), *Exemplary Science for Building*

However, while OERs are easily accessible and freely available on the web, the challenges to realizing their potential in K-16 education include a lack of awareness of the existence and potential impact of OERs, the glut of poor resources on the Internet, and a lack of experience of K-12 teachers and university instructors in experimenting with embedding them in existing lessons.

Starting Slow

If it's on the Internet, it must be true, right? Along with becoming a repository for myths and urban legends, the Internet is now home to thousands of unvetted lesson plans, lesson ideas, and lesson recommendations. Just Google 'water cycle lessons' and see what you get (we got over 3 million results in one quarter of a second). How is a teacher supposed to know which lessons, if any, are reliable, proven, or aligned with any set of standards? This is the primary shortcoming of surfing the Internet for lessons. So, that is not the goal of exploring OERs and incorporating them in existing lessons. Used appropriately by teachers interested in building their instructional fluency, OERs have the potential to revitalize existing lessons and improve the delivery of high-quality, engaging, and rigorous STEM content.

While working on a two and a half year project with a select group of middle and high school math and science teachers from across the nation, we learned some valuable lessons about introducing the uninitiated to OERs. The goal of our project was to assist these teachers in revamping an existing lesson by incorporating useful OERs that would challenge their students to explore content in exciting ways. Here are some things to keep in mind when investigating OERs.

Start with an existing lesson. Using OERs does not require teachers to create new lessons, nor should it. Teachers are more agreeable to putting another tool in their toolbox if it complements something they already have. In our project, we found that teachers were comfortable working to upgrade one of their existing lessons rather than starting from scratch.

Target models and simulations. Surf the web. Yes, we said it, but remember that we are not espousing that teachers surf the web for lessons. The easiest way to incorporate OERs into an existing lesson is to find a model or simulation related to the topic. As an example, for a lesson on the gas laws, check out: <http://www.grc.nasa.gov/WWW/K-12/airplane/Animation/frglab2.html>

Develop interesting questions. This animation above allows students to freeze (hold constant) different variables involved in the gas laws (mass, volume, temperature, and pressure) and observe the results. The 'value neutral' part of a model like this is that it rarely comes with instructions. This is actually a benefit to teachers because they are free to develop a menu of questions or investigations that require the students to manipulate the online model in ways that align with the objectives of the lesson.

Allow for exploration. The benefit of an online model is that it can be manipulated repeatedly with new inputs. Teachers can challenge students in ways that require them to explore the model or simulation multiple times in order to study the content and solve problems. With the above animation, students can explore questions like these:

When you freeze mass and volume, what is the effect on the temperature if the pressure is changed? What is the effect on the pressure if the temperature is changed?

When you freeze mass and temperature, what is the effect on the pressure if the volume is changed? What is the effect on the volume if the pressure is changed?

When you freeze volume and temperature, what is the effect on the pressure if the mass is changed?

When you freeze pressure and temperature, what is the effect on the volume if the mass is changed?

In the last two scenarios, there is no question about what happens to the mass if the pressure, temperature, or volume is changed? Why not?

Summary

OERs are not lessons, but rather the building blocks of lessons. Throughout our project, we worked with over 50 teachers who revitalized their science and math lessons with embedded OERs—lessons that they are currently using in their classrooms and sharing with their colleagues. It is their excitement about the success they are having with embedding OERs in more of their lessons that prompted us to introduce the idea of OERs to the larger science education community. We are in the process of cataloging the lessons and revisiting the OER links in the lessons. When this updating is complete, we will share in greater detail what OERs the teachers selected in order to create a classroom environment in which their students routinely "compute, investigate, and innovate." In the meantime, start surfing the web for models and simulations that support your lessons—your students will thank you.

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