Technology Tools to Build a More Accessible STEM Program: "Doing" Science Like a Scientist

Center on Technology and Disability
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The U.S. Department of Education established the **Center on Technology and Disability** (CTD) to provide a wide range of assistive technology resources for states and districts, families, teachers, service providers, advocates, researchers, teacher training programs, disability organizations, and vendors.

The CTD website – www.ctdinsitute.org – has a resource library with more than 1,000 assistive technology-related materials; a webinar center with an active schedule of informational presentations, and extensive archive; and a learning center for those who want structured, in-depth modules.

The Center on Technology and Disability is funded by the U.S. Department of Education, Office of Special Education Programs (OSEP) under award #H327F130003.

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Use accessible technologies and authentic STEM experiences to encourage "STEM for All"

Mainstream technology tools with built-in accessibility features, and the availability of virtual reality, simulations, and augmented reality present new opportunities for students with disabilities to access and engage with STEM (science, technology, engineering, and math) content. This brief presents ways for educational leaders to incorporate accessible technologies and STEM tools with principles of Universal Design for Learning (UDL) to create STEM programs that are more accessible for students with disabilities to prepare them for a lifetime of scientific literacy and STEM-related careers.

Introduction

STEM education serves as the foundation of innovation in our society. Innovative products often derive from a problem or challenge that requires a unique solution, making it imperative that all students, including those with disabilities, have access to a rigorous STEM curriculum. Thanks to more accessible technologies and a concerted nationwide effort to address underrepresented populations in STEM fields, more individuals with disabilities are pursuing careers in science and engineering[1]. However, many students with disabilities still lack access to a rigorous and accessible STEM curriculum, and may get the message that STEM careers are not for them. This situation places these students at a disadvantage given that STEM jobs are among the fastest growing and highest paid occupations, with STEM jobs expected to grow to more than 9 million by 2022.[2]

In an increasingly complex world, all students need to be scientifically literate. While some students may go on to pursue advanced careers in the sciences, basic scientific literacy is critical for all students. They need to understand what it means to think like a scientist, and how to evaluate information that is called "scientific". Many of the careers of the future will require that students can collaborate and solve problems using STEM skills. Struggling students are no exception — they will need the same types of knowledge and skills, and often will require additional supports to be successful.

Research has shown that the most meaningful learning happens when students are engaged in authentic activities that ask them to think and behave like chemists, computer programmers, mathematicians, engineers or archeologists — that is, when they are engaged in activities that mirror the real-life tasks of STEM professionals. These activities might include the use of virtual environments and simulations, developing models of scientific phenomena, and using collaborative tools like Google

[1] Sparks, S.D. Students With Disabilities as Likely to Enter Science Fields, New Fed Data Show. (2017). EdWeek. Retrieved from http://blogs.edweek.org/edweek/inside-school-research/2017/02/students_with_disabilities_in_college.html?cmp=eml-enl-eu-news3

[2] STEM 101: Intro to tomorrow's jobs. (2014). Occupational Outlook Quarterly. Retrieved from https://www.bls.gov/careeroutlook/2014/spring/art01.pdf

docs, video conferencing, and online communities. These types of activities can present new challenges for struggling students and those with disabilities.

Physically 'doing' science

Physical tasks are an important part of many STEM lessons, from taking soil samples, mixing chemicals, using Bunsen burners, recording data, building models, and performing dissections. This type of physical work can present significant barriers for students with disabilities. Students with dysgraphia, poor motor control, emotional/behavioral disorders, orthopedic disabilities, cognitive impairments may have difficulties with some of the physical requirements of the STEM classroom.

Educational and assistive technologies can help students with the physical demands of science lessons by providing alternative experiences for building science proficiency and knowledge. These technologies can benefit students in two ways. First, they provide students with a substitute for the natural world, as with simulations. Second, they can allow students to visualize and interact with the natural world in ways that would typically be impossible, because the processes involved are too fast, small, slow, or large to be easily perceived by people, or are not practical to repeat. For example, a virtual dissection both ensures access for a student who is unable to safely use a scalpel, and allows for multiple viewings, repetitions, and manipulations of organs and tissue without the need for multiple dissections.

Virtual experiments and activities

When — because of disability, cost, time, safety issues, or accessibility — students are unable to engage in certain physical science activities, virtual experiments and dissections can be a viable alternative. Virtual reality activities give students opportunities to see a representation of real bench science and to manipulate it with virtual tools.

Simulations of the natural world

Virtual worlds involve using technology to display a simulated setting and allow participants to work and interact within it. Simulations may be relatively simple, as with simulations which allow students to manipulate animal population density, food supply, and other conditions affecting reproduction and the ecosystem; while others are more complex, allowing groups of students to work together, making observations, collecting data, testing hypotheses, and communicating with one another.

Virtual instrumentation/data collection

Technology enables a wide range of devices to connect to the Internet so that science activities can be conducted virtually and over great distances. Tools and websites that enable students to interact with scientific equipment virtually are now available. In addition to providing a more accessible experience, this technology can afford students opportunities to use equipment that is often too expensive or dangerous for the classroom.

Implications for educators

Teachers can use technology and classroom supports in a variety of ways to accommodate students who have physical barriers to performing standard science tasks:

- Use instructional technology, including interactive virtual reality applications, to support student visualization and modeling.

- Arrange teams so that students with disabilities are paired with other students who can support them in performing some tasks (e.g., mixing chemicals, making cuts with a scalpel).
- Connect with other educators and sign-up for STEM learning newsletters, through listservs and collaborative learning platforms, to share strategies and ideas.
- Explore additional teaching strategies and resources for making science accessible for all students.

Technology resources

Adaptive Curriculum

This interactive visualization and simulation software for middle and high school science features many different activities and simulations linked to national science standards. It also features virtual labs, simulations, quizzes, built-in glossaries, lesson plans and other classroom materials.

Digital Frog

Fully interactive frog dissection that teaches students about frog anatomy and major body systems as well as allowing students to explore the diversity and ecology of frogs. It includes several accessibility options for students with disabilities or other learning needs.

Discovery Education – Free Virtual Field Trips

Take students beyond the classroom and into some of the world's most iconic locations for rich and immersive learning experiences. Explore upcoming educational events.

Froguts

Froguts allows students to practice steps for frog dissection before or instead of hands-on dissection. The lab is interactive and provides explanations. Dissections of fetal pig, squid, and owl pellets are also available.

Howard Hughes Medical Institute BioInteractive: Virtual Labs

HHMI's virtual labs are fully interactive laboratory simulations that include a bacterial identification lab, a cardiology lab, a neurophysiology lab, and a virtual ELISA (Enzyme-Linked Immunosorbent Assay) using human antibodies to diagnose disease. It features built-in glossaries, quizzes, background information, and other materials for the classroom.

JASON Mission Center

The JASON Mission Center is the online repository of related educational content associated with the JASON Project. Students can make use of online games, simulations, virtual labs, and other multimedia resources; teachers can access curriculum materials, and purchase curriculum units for fifth through eighth grade students.

NASA's Virtual Microscope

The Virtual Microscope is a NASA-funded project that provides simulated scientific instrumentation for students and researchers worldwide as part of NASA's Virtual Laboratory initiative. The virtual microscope aims to present the user with a method for exploring these pre-captured image data as if they were using the real instrument in real-time. It includes educational materials and training animations.

NASA Virtual Field Trip

The Virtual Field Trip is an immersive multimedia application developed to support student and user exploration of areas on Earth that have been identified as analog sites to regions on Mars. Analog sites are those areas that share some common traits with sites on Mars and have been identified based on their significance and importance to NASA.

STEMfinity

Explore this webpage for a library of resources to support STEM instruction for students, K-12, as well as professional development for educators.

"Assistive and Instructional Technology Supporting Learners with Disabilities"

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