# Technology Tools to Build a More Accessible STEM Program: Questions, Argumentation and Use of Evidence

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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.

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# Technology Tools to Build a More Accessible STEM Program: Questions, Argumentation and Use of Evidence

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 will often 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.

## Questions, argumentation, and use of evidence

Knowing how to engage in signature scientific acts, such as formulating questions and using evidence in arguments is an important part of science learning.[3] Students who use evidence to make claims and interact with other students who are also presenting evidence-based arguments are engaging with authentic activities as part of a scientific community of practice.[4]

In classrooms stressing questions, argumentation, and uses of evidence, students develop original questions and theories, and share them with their classmates. In these classrooms, students take on the role of critic and defender of positions, rather than learning about scientific principles through teacher lecture, or textbook reading. These activities may encourage students to become more actively involved in their science learning, allowing them to discover well-established principles for themselves.

Classrooms that facilitate collaboration and scientific discourse among students have the added benefit of helping students develop their critical thinking and reasoning skills and encouraging scientific thinking. In a process akin to peer review, students develop questions, present hypotheses and observations, debate conclusions, and use one another's ideas as a jumping off point for their own conclusions.[5]

Struggling students may find this process challenging, because it requires being able to abstract their own opinions and beliefs from the evidence, comment on the relationship between the evidence and the claims, and use sophisticated and specific language.

### Constructivist tools to support question development

Constructivist tools allow students to build their own knowledge structures. They help students to make predictions and test their hypotheses. Through these activities, students have a structure to engage in the process of being scientists.

### Scaffolds for evidence assembly and argumentation

In recent years, many science educators have focused on the process for how students use evidence and construct an argument by using three main components of discourse: a claim, evidence, and reasoning.[6]

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[3] Duschl, R., & Osborne, J. (2002). Supporting and promoting argumentation discourse. Studies in Science Education, 38, 39-72.; Krajcik, J., & Blumenfeld, P. (2006). Project-based learning. In K. Sawyer (Ed.), Cambridge handbook of the learning sciences. New York: Cambridge University Press.; Marx, R. W., Blumenfeld, P. C., Krajcik, J. S., Blunk, M., Crawford, B., Kelly, B., & Meyer, K. (1994). Enacting project-based science: Experiences of four middle grade teachers. The Elementary School Journal, 94(5), 517-538.; White, B., & Frederiksen, J. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. *Cognition and Instruction*, 16(1), 3-118.

[4] Developing a STEM Identity. Office of Educational Technology. U.S. Department of Education. Retrieved from https://tech.ed.gov/stories/developing-a-stem-identity/

[5] STEM 2026: A Vision for Innovation in STEM Education. (2016). Office of Educational Technology. U.S. Department of Education. Retrieved from https://innovation.ed.gov/files/2016/09/AIR-STEM2026_Report_2016.pdf

[6] Goldson, Cora. (2014). How Student Engagement Facilitates STEM Interest. NOVA Education. Retrieved from http://www.pbs.org/wgbh/nova/blogs/education/2014/10/how-student-engagement-facilitates-stem-interest/

These practices do not simply emphasize students getting the correct answer. Rather, they focus on students using their evidence appropriately in a well-reasoned argument, even if the answer is not factually correct.[7]

## Collaborative science education tools

Computer-based collaborative learning tools vary widely, but most function as a common space or forum for users to share ideas. They often resemble Internet bulletin boards or wikis. For example, students may have access to space to post notes; view peer comments; share new ideas; respond to the suggestions of others; link to new information; or question a peer's assumptions. As the discussions take place, all users can see the progression of ideas. Data, images, and video clips are saved so that students can return to the discussion and share knowledge. Teachers can use both freely-available collaborative programs (Google Docs, etc.) and purchased programs to create a collaborative learning space for their students.

## Implications for educators

To accommodate students for whom authentic scientific activities are challenging, teachers can try the following strategies:

- Use the Internet for web-quests and other ways to allow students to develop and research questions about the subjects they are studying.
- Seek out inquiry-based technology curricula that support students' development of questions and use of problem-based learning.
- Show students how they can construct a scientific argument using evidence, and explain that this process is probably similar to the ways they argue for who is the better artist, sports hero, or celebrity.
- Use visualization tools, including concept mapping, to develop both interrelated questions and question-boards and structured science arguments that have the main features of a claim, evidence and reasoning.

# Technology resources

Debate Graph

Students can participate in group debates or build collaborative brainstorms on any complex topic. Subject maps and spider graphs can be saved and presented to the class or scored by the teacher.

Inspiration

A full-featured desktop program, compatible with Windows and Mac computers, Inspiration has many formatting options, built-in templates, and useful tools like a word guide, spell check, and integrated text-to-speech. It even has a function that will automatically turn a graphic organizer into a slide show that can be exported to PowerPoint for further editing.

[7] STEM 2026: A Vision for Innovation in STEM Education. (2016). Office of Educational Technology. U.S. Department of Education. Retrieved from https://innovation.ed.gov/files/2016/09/AIR-STEM2026_Report_2016.pdf

[Mindomo](#)
Another web-based tool with a companion iPad app, Mindomo lets students create graphic organizers that can double as presentations. The presenting function has a unique zooming tool that allows users to focus on individual elements of the organizer

[Popplet](#)
A web-based graphic organizing tool, which also has an iPad app, Popplet limits students to basic formatting and functionality which could be helpful for students who are easily distracted.

[Sway](#)
Sway is an easy-to-use digital storytelling app for creating interactive reports, presentations, and more. Its built-in design engine helps you create professional designs in minutes and allows projects to be shared and edited digitally.

[TalkBoard](#)
With TalkBoard students can visually express and build on ideas using iPads and allows students to illustrate collaborative ideas instantly. This app can be particularly excellent for language learners, autistic students, and visual learners.

[Twiddla](#)
Twiddla calls itself a "meeting platform" where students can collaboratively mark-up graphics, photos, webpages, and uploaded documents. Students may opt to brainstorm on a white canvas or create mind maps as well.

[VoiceThread](#)
VoiceThread allows users to upload a variety of media (documents, images, video and audio files, presentations) for sharing and discussion. Peers can comment through recording an audio message, sharing video, by text, or phone. The platform provides a space for students to present their work, discuss it with peers, and defend their reasoning. VoiceThread has many built-in accessibility features, as well as a screen reader version – VoiceThread Universal.

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