STEM SCHOOL STUDY

How is technology used in inclusive STEM schools?

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INTRODUCTION

The "T" in STEM, technology, plays an important role in inclusive STEM schools, and is incorporated into curricula and implemented in classrooms in many different ways. When we visited schools and talked with teachers, we looked for and asked questions about

- **How teachers use technology in their classrooms, and**
- **Why they use different types of technology.**

We defined technology broadly, including

- **Basic technology:** iPads, laptops, smartboards, and Microsoft Office © programs (e.g., Word, Excel, and PowerPoint), and also,
- **Skill-based technology** such as advanced lab equipment, robotics, or engineering software.

We saw frequent use of basic technology, and far less incorporation of skill-based technology. Skill-based technology was present in only 21 of the 134 lessons we observed, and most of these were classes that focused specifically on particular technologies (e.g. AutoCAD). However, when interviewed, teachers spoke at length about how skill-based technology is used in problem- and project-based learning (PBL) experiences. Thus, *what we heard and what we saw were not always in alignment*. Here, we discuss how both types of technology were used in classrooms with students, and we share some examples from teachers of how they have incorporated skill-based technology use into their classrooms through students' completion of PBL projects.

BASIC TECHNOLOGY

Basic technology such as computers, iPads, smartboards, Microsoft word processing and spreadsheet software, and internet use was not only observed across classrooms, but were also mentioned frequently by teachers. Teachers emphasized the transformation of their classrooms into "student-driven, tech-focused" learning zones, which often included 1-to-1 laptops or iPads, and digital learning resources to replace textbooks. These tools supported teachers' and students' engagement in learning, but were often observed as being used to substitute or replace non-technological tools that allow students to do the same type of work (i.e. pen and paper note-taking versus note-taking using iPads or laptops). Thus, while basic technology use was prevalent in classrooms, use of basic technology may not have necessarily deeply enriched or created new types of learning experiences for students.

Teachers also noted the **importance of basic technology for information literacy.** Using basic technology in this manner promotes students' abilities to navigate and master more foundational technologies like "creating their Gmail account[s], [and becoming] Microsoft Office Specialists" in Word, PowerPoint, and Excel, and web-based programs like Google Drive to facilitate collaboration outside of the classroom. When students possess information literacy skills they are able to critically evaluate and consume information, especially information that is found on the internet. Teachers noted that these skills are valuable and transferable across contexts in students' lives. For instance, these skills have the potential to serve students throughout their STEM high school careers, and as well, in college and across many types of workplace environments.

In summary, while we saw vast use of iPads, laptops, and desktop computers in classrooms, it appears that one of the strongest benefits of these technologies comes in the form of technology literacy, as we rarely observed basic types of technology used in ways that transformed or deeply enriched learning experiences for students.

SKILL-BASED TECHNOLOGY

Skill-based technology includes coding software used by students to create websites and program robots, engineering and design software such as AutoCAD, digital and video cameras, 3D printers, and advanced laboratory equipment such as gel electrophoresis. Although skill-based technology use in inclusive STEM school classrooms was observed at low frequencies, interviewed teachers frequently reported that PBL experiences provided opportunities for students to engage with skill-based technology. Teachers indicated that PBL often involves students completing a longer-term project with multiple stages, and use of skill-based technologies assists students' creation of end-products.

Additionally, observations of skill-based technology use was not limited to in-school classroom instruction. We also observed use of this type of technology in out-of-school-time activities including STEM-related clubs (e.g., Robotics). These out-of-school activities taking place after regularly-scheduled school hours were enriching and enjoyable for those students who participated; however, because they were optional, only those students who participated gained exposure and hands-on experience with different types of skill-based technologies.

Overall, use of skill-based technology may have been observed at lower frequencies for several reasons. Skill-based technologies are often expensive, and implementation of such technologies also requires teachers to have knowledge of how to use the technology and how to teach students how to use the technology. Inclusive STEM schools are taking an important first step by offering students opportunities to engage with this type of technology during after-school hours. However, if advancing students' more-complex, technological skills is important to the mission of inclusive STEM schools, skill-based technology also needs to be present in classrooms where all students are able to gain exposure and interact with it.

INTERVIEW VIGNETTES

Below are several examples where teachers described how PBL projects help teachers to incorporate skill-based technology use for students in their classrooms.

“...our students are working on a Mixonium in bio-tech [class], which is kind of a neat new cutting edge shareable social networking platform where you can have seven panels that have diverse media types. It’s just an interesting new format where you can present video, audio, text, images all on one platform. It’s just very shareable. We try to keep our ear to the ground and see what’s going on in business and replicate some of those models that our kids learn to use. That’s why they’re using CAD [computer aided-design] software. They learned the whole Adobe Suite. They learned how to make their own images, Flash animations, and commercials. The product in and of itself, especially in bio-tech [class] because it’s a tech course, has its own learning in addition to the content that is going into the product.”

“We had a project that came along, the first one was in-house. Mr. C had a need. We spoke about the application we have, Edmodo, which allows teachers to deliver content in classes. It’s a class-specific, regular learning management system, but not a lot of the teachers here use it. They did not have a favorable opinion of it, as we found when we did surveys, mostly because they just didn’t know the program and just didn’t know how to apply it. So we had the students tackle that issue and to develop tutorials - video based and print based - for the teachers and for the students. So that was the first project that we went through. This first one the kids went into with much apprehension. They came out of it not very happy because they did not like Edmodo. So we had to talk to them about if you’re going to get into the life of technology, it doesn’t matter if you’re going to be able to compute or if you’re going to be designing rockets, whatever, you’ve got to deal with documentation, learning the skill levels of people you’re going to be working with, finding out what their needs are... all of this stuff that they’re learning in the process. They started buying in a little.”

“This year probably the biggest one I helped bring in was this Protagonist Labs, which is this computer game company. They created this online story-telling game called Storium that I helped get into the classrooms here to do a beta test on. They had a successful Kickstarter and raised a quarter of a million dollars or something like that. One of the things the Kickstarter unlocked was Storium for schools, but nobody at Protagonist Labs had any idea of what that was going to look like. I reached out to them and I’ve been able to have our students shape that for them and figure out what it’s going to look like. It’s kind of cool to see this real world application. These kids are getting to test something that’s having real world results on how they’re designing their platform for future use.”

“Then we had one competition, a national competition, called CyberPatriot. That is a high school-based, national competition out of the Air Force, and what students do is they can come in with absolute zero skill set and they go into computer systems, into the operating systems -- Windows is what we’re working with this year, but we’re on Macs, it’s interesting -- but they go in and they get a process called hardening. What they do is they can go in and take out malicious code. So we’re on the good side of hacking is basically what it is. The kids got into this and bought in completely. It was jump in with both feet. This time I just watched this class completely turn around. We’ve taken CyberPatriot all the way through the year until... next year it’s going to become a club. We’ve just had wild response to it, people wanting to do it.”

KEY TAKEAWAYS

Technology use in the classroom is rapidly changing teachers' instructional practices, students' learning strategies, and school districts' approaches to education. Investment in technology has emerged as a top priority for many schools, including inclusive STEM schools, who highlight technology use and integration as central to their missions. However, at present, it seems that the incorporation of technology into classrooms skews towards basic technologies, with the possible exception being observed in the context of certain PBL experiences, which may provide opportunities to engage students with technologies they otherwise might not be exposed to. With either type of technology, teachers spoke about the necessary and transferrable 21st century skills that students learn, which can be applied in and outside of STEM majors and careers.