Title: Problematizing the STEM Pipeline Metaphor: Is the STEM Pipeline Metaphor Serving Our Students and the STEM Workforce?  
Authors: MATTHEW A. CANNADY, ERIC GREENWALD, KIMBERLY N. HARRIS  
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Currently, the STEM pipeline metaphor is commonly used to show who is entering STEM careers, based on different benchmarks throughout one’s life, or who “leaks out” on the way to getting to such a career, even if they did meet the first (few) benchmarks. This metaphor may be useful in some ways, but it has several limitations. The trajectory that it implies fails to include many people who end up in STEM careers, but who did not enter the pipeline at the beginning of it. It’s a one size fits all approach to describe people’s paths from middle school to STEM careers. It is also used to inform policies and policy changes, but since there are limitations, these policy changes may not be (as) useful. The pipeline metaphor suggests that if more people start at the beginning of this pipeline (e.g. by taking algebra classes by middle school) and if they patch the leaks, more people will flow out at the end of it and end up in STEM careers.

This isn’t fully accurate, since there are many reasons why a person may not end up in a STEM career even if they enter the pipeline. After all, there is an assumption that a person needs to reach/go through each benchmark and if a person accomplishes all benchmarks, they are certain to enter a STEM career.

Additionally, the skills and requirements needed in STEM careers change too quickly and the pipeline metaphor is too rigid to accommodate for this. There are also huge differences between different types of sciences and thus between the benchmarks needed to get into such a career (e.g. life sciences). Two or more pipelines could be an alternative to solve this issue, however, this still doesn’t solve any of the other limitations the metaphor has.

Another model that is more flexible and includes different factors as well as allowing for later access onto the STEM pathway would be better. The pipeline only focuses on academic benchmarks, but factors such as the quality of education as well as access, interest in STEM, and motivation are important as well. It would also be beneficial to include efforts to understand why people enter or exit pathways to STEM careers and in which other ways, besides academically, STEM skills can be acquired.

Overall, the pipeline and its benchmarks reflect the path, learning style, and socialization of white men. Career decisions are influenced by life contexts, especially in early adulthood. This means that getting married or having children may push someone in a certain direction when it comes to their career.

The newly proposed model is a four-composite typology model that allows for nuances such as scientists who do not follow the traditional pipeline, yet still end up as scientists.

For example, one out of three people who didn’t show any interest in science in middle and high school, nor took all the benchmark classes (e.g. algebra, calculus, major in science in college) still ended up with life science degrees. And over 60% of people who became scientists or engineers either did not take calculus or didn’t develop that early interest in science.

This all indicates that taking calculus isn’t a necessary benchmark (many people who didn’t take calculus still become scientists or engineers), nor is it a sufficient benchmark (many other people who did in fact take calculus ended up in a non-STEM related career). It’s very important that we keep in mind that people who don’t have all the “required” benchmarks according to the pipeline metaphor are still able to enter successful STEM careers. It’s oftentimes minoritized people who are less likely to be able to flow throughout the entirety of the pipeline (if they even get to enter it at all).

Limitations to this four-composite model include that it isn’t as easily interpretable visually as the pipeline model, and it’s still rigid.

In any way, pathways need to be seen as a combination of factors that end up drawing people towards STEM. They aren’t all required to ensure success, and any combination of pathways can happen. Rather, they need to be seen in individual contexts and need to allow space for constraints, opportunities, and affordances on a system-level.

Key Terms

* STEM Pipeline: This metaphor implies that to go from 8th grade and end up in a STEM career, there is one inlet into a STEM career, one outlet, and one direction of flow through a pipeline that gets progressively smaller as it has leaks where people who entered the pipeline miss benchmarks and end up not making it into a STEM career.
* Supply side model: The STEM pipeline is seen as such, meaning that it is believed the more people enter this pipeline, the more will come out at the end of it and enter into a STEM career field.
* Pipeline benchmarks: The steps a person needs to take or the things a person needs to accomplish to make it from the beginning of the STEM pipeline to the end. These benchmarks include taking algebra by the time they attend middle school and having taken (a) calculus course(s) by the end of high school, graduating high school, attending college and majoring in a science, and eventually entering a STEM career.
* Four-composite typology: a model that allows a more nuanced and flexible look at how people end up in STEM careers, indicated by academic credentials, (early) interest in STEM, both, or neither. This typology emphasizes individual agency.