Virtual Outcomes

K-12 Data Science Workshop

We are asking for you to reflect on what should be the desired outcomes for data science education at the K-12 level. You are welcome to consider outcomes for different levels of the system. For example:

- Student-level outcomes: development of specific skills and proficiencies, developing interest or disciplinary identity
- Policy and practice outcomes: access to opportunities, funding, educator preparation and professional development

All ideas are welcome. You need not attach your name to an outcome. **We appreciate your willingness to share a few ideas below:**

Across all disciplines students can learn from and with data for purposes of the disciplinary learning and at the same time they also need to learn basic skills and competencies for working with data, not just the mathematical aspects but the ethical and social aspects. Many lists already exist about what needs to be learned, and why all students need this, but the question is how to work that learning into the context of schools and teachers starting where they are today.

This requires many disparate efforts, is perhaps easiest where schools are already moving to projec-tbased-learning pathways through high school.

Agreed Helen and would add that there are great opportunities to bring this into middle schools using an Integrated approach.

Agree, Helen and Kristin. Even with elementary students, data can be collected and analyzed to draw conclusions or make predictions. My own 7-year-old daughter likes to collect things and count them, sort them, etc., all of which is data literacy.

One potential organizational structure would be to separate Data Literacy education (for all Americans) from Data Science education (for people who may become data-using professionals.)

Agreed - data literacy can be developed as part of math and science (and really in all subject areas to promote the idea that it's used everywhere and can help bring about social justice, for example) in the early grades and supported in high school math and science (and again in other subject areas, too); Data Science courses in high school are an opportunity for students to explore what Data Scientists do and see how data can be used to inform decisions.

I think Kim's framing here is interesting and an important thing to consider...are they parallel tracks? sequential tracks? both and? either or? I think both are necessary to include in PreK-12 education, but that there are differences among them.

Wondering if we can think about talking about data literacies versus 'literacy' because the plural implies the multiple ways we communicate with and about data through a range of modes/media.

Student-level outcomes - **Adewale**

- Students need to be able to make connections from the real world situation, the data that represent the real world to the procedures (math and data sci. as tools) for analyses and interpretation of the data and the situation.

- Students should be able to discuss how data represents the world they are describing beyond numbers.
- A balance of Quant and Qual data and appropriate use dependent on the purpose

Policy and practice outcomes: Educator preparation - Adewale

- Mathematics teacher education can serve as a space to prepare future teachers to teach data science to their students. Many of the mathematics teacher education courses across the US now incorporate mathematical modeling classes which give preservice teachers the opportunities to work on activities that involve data collection, data analysis, interpretation, and validation. To this end, teacher education classes should look deeper into this space to equip future teachers with the skills needed to teach data science skills in their classrooms.

- Students should be able to define “data science,” tell someone what it is, how to engage in it, as well as be fluent in it (or at least start to feel as if they are)

I think it’s incredibly important to find ways to integrate Data Science into students’ core classes**,** but doing so in a way that relates to them and helps engage them in their world. Data comes alive when you see what you can do with it, and use it to help make sense of your world, and this is a critical area for our students who will be entering the “adult” world and will need to have skills that we didn’t need growing up.

-Start with the implementers-teachers-and provide a structure by which they see themselves delivering data-rich content integrated into their areas of expertise as a support tool for student learning.

Many different goals have been emphasized today. I’d like to emphasize the greater social good goal of data work and the need for it to be integrated throughout the curriculum. The definition I find resonates especially well with this idea is: “The desire

and ability to constructively engage in society through and about data"...with the data work "promoted for and via greater social inclusion" Bhargava, 2015

-Student outcomes need to include a cross connection between using data as a learning tool and as a skill to explore the world around them-"I wonder…" and as a tool to solve community-based problems.

-Data fluency begins with student engagement with data collection and organization. Building off of those experiences, teachers can use skills in visualization, analysis and interpretation to find meaning in the data they collect.

Data Science is everywhere, is there an ideal place to support teachers in teaching it?

Data Science supports sense making, it helps us to make sense of the world around us and drives curiosity.

I worry about manipulating data in any content area.

Another word for Data Science is in the STEM umbrella.
Data science have shared techniques used by all.

Let's think about best practices to bringing this into the classroom…..

- I see, I think, I wonder regarding different data sets to support sense making
- How to read data sets with only data first then adding in the headers
- Asking students to tell us, "what do you think this data means based on where you see it going?"

I found the comments around teachers not having time to integrate data science due to the "tyranny of testing oppression" very important. It is a double edged sword. If data science standards are added thoughtfully into the system even with the best of intentions, then the knee-jerk reaction higher up within the system is to include high-stakes accountability testing to those standards, which then has negative impacts on teaching and learning data science as it is now driven by whatever may appear on the state test. Conversely, if it is not tested then folks won't address it because there's no time. This is a significant issue that will require much time and attention to dismantle within the larger systems of education nationwide.

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Aanand Vasudevan
Data Acumen / Literacy

- **Student-level outcomes:** Development of data driven computational, statistical and mathematical thinking along with specific skills and proficiencies to help students become better citizens in their decision making
- **Policy and practice outcomes:** Modernizing of curricula (to incorporate data driven thinking in curriculum, assessments) across subjects, access to cross-curricular learning opportunities, educator preparation and professional development as well as equitable learning pathways from K-12 to high ed to the workforce

To advance in way that is not further overwhelming teachers, researchers can advocate for greater available time for planning and learning in work schedule, as is convention in other nations : https://ncee.org/empowered-educators/ .

Policy efforts can include advocating for modernization of teaching conditions that align with identified "needs" and research.

I think data acumen by teachers is needed to make data-driven decisions and assessments (data skills of teachers).

And I think that is different than teachers teaching their students how to have data acumen/literacy for the world around them (data skills of teachers + pedagogy for how to teach those skills to students).

Data Science

- **Student-level outcomes:** Development of data driven computational, statistical and mathematical thinking along with specific skills and proficiencies to enable and empower students to become proficient consumers and producers of data to complement their program of studies and workforce aspirations
- **Policy and practice outcomes:** Modernizing of math curricula (to incorporate data driven thinking in curriculum, pedagogy & assessments); Integration across mathematics, statistics & computer science to provide cross-curricular learning opportunities, educator preparation and professional development as well as equitable learning pathways from K-12 to high ed to the workforce; partnerships with industry to drive relevancy

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Data Science

- It requires a foundation on descriptive statistics and computer programming (Python for instance). Inferential statistics can be applied in the last years of school. It provides opportunities to connect mathematics (functions, calculus) with artificial intelligence (machine learning) from school.
- Student-level outcomes: Create basic data models. For example, for discovering physics laws from experimental data (science). They can use car traffic data to model traffic light systems (engineering and technology).

As a teacher who is about to delve into teaching data science for the first time I am overwhelmed with the amount of work and lesson planning, but I still need to find time to reach out to other communities and connections. Something that I think would be helpful for myself and my students is opportunities to have data scientists and other experts in the field come to my classroom and teach a lesson or lead them in some sort of exploration to get them excited and really generate some buy-in and connect with people/communities outside of our school. If there was a connection to get something like this started that would be fantastic.

[Agency-funded researchers can be encouraged by program managers to do just that as part of their "broader impact" effort. Can advocate to program managers that more researchers enact their BI outside of the confines of campus/academia.]

[I was thinking the exact same thing. I would like to reach out to our local public school district to offer professional development to k-12 teachers who are interested in learning to teach data science. BTW, I teach at the community college and we are hoping to increase our student body of just-out-of high school students. How do you see this happening?] [Currently one of my central office supervisors has been asking around finding businesses and people who work with data science who would be interesting in collaborating. Hopefully it leads to something great, I am thankful to have that support, because otherwise it would just be one more thing on my plate.] [Some states have established STEM Networks that may help identify potential collaborators]

I am listening into the discussions and concerned about teachers' time. I taught HS Chem and have been including data science, etc since the early 80's. We need admin and state leaders on board. We need business and industry to broadcast their needs across the disciplines. I'm happy to hear about the partnerships developing. We recently completed a biology unit to bring more data analysis into the high school curriculum. Our teachers were hesitant but acknowledged the only data analysis they were doing was based on Punnet Squares and not raw data. /// The idea should be that integrating DS into any other discipline is taking the opportunity to further learning about data, and picking up any skills that are needed to make data science useful for that discipline. It should not be jamming all of data science into the class and crowding out what is there to be taught. BUT there needs to be space somewhere (else) to tie all the pieces of DS together, and to learn DS for DS sake.

HOW DOES DATA SCIENCE ALIGN WITH OTHER AREAS OF INTEGRATION? I feel like we are missing out on a huge issue. We are talking about data science education, and really focused on integration. However, there are lots of other competing areas (computational thinking, computer science, artificial intelligence, cybersecurity, digital citizenship, technology integration, social emotional learning, culturally relevant pedagogy, etc.) - how do we work together with these other areas to push forward a way to move education forward? If we care

about K-12 education, we need to find ways to make this achievable for schools and teachers, especially within the context of the tyranny of testing and other systemic factors.

Cannot agree more… especially as we think about building a K-12 pathway through each of these, and end up requiring elementary to sift through the aspirational goals set forth and figure out what “counts” for their kids. Kim’s comment early on (above) about separating “Data Literacy” as a practice within other disciplines from “Data Science” as a discipline in and of itself is a start (it’s already there in the NGSS, for instance). There needs to be space for experiences built throughout that help students get to that end goal--some of it needs to be highly structured and intentional in teaching the Data Science part, some needs to be supportive of the surrounding contexts.

Late to the party… but - wondering if we can think about the nature of data- as more than just quantitative in nature. Data can be a range of things and it’s about how the data and the process of interpretation helps us to say something about our life/community/a topic we are passionate about. I also wonder about ‘literacy’ versus ‘literacies’ and implore us to think about literacies as a framework - because it allows us to talk about data literacies as more layered, as interconnected to reading, writing, and sense-making, in our day to day lives, and shaped by our social/cultural worlds. P

Also, I think the more specific about what this means in practice for teachers across the PreK-12 progression and across disciplines should be kept in mind. Often times these conversations can be left at the 40,000 foot level, but the teachers that I work with across the country want to know what it means for their students tomorrow in class. [Yes! Same. And when they come up with creative and engaging activities, they fret that it's "not enough," and wonder "does this count as data science?"] [I think the challenge is that when we keep talking about it like this author says at the 40K level, teachers can't see the ways that small practices can be data science... small 'micro moves' towards it... when you use the language, when you are engaged in transparency around the learning experience... it will resonate with kids and teachers can actually manage it.] What do they need to adjust in their teaching practices? What should they look for in the students’ outputs as a sense of mastery towards developing the skills? There are some key research questions that needed to be answered, but there is also a large need to translate existing research into practices that current and future teachers can start using now.

Other comments re: across grade levels and subject areas: I think approaching educator preparation and professional development from the perspective of sequences / progressions AND collaborations in mind is important so that we do not repeat shiloh-ing data components.

→ i think the challenge with teacher education right now is that when you use the word ‘data science’ (unfortunately)the language can be alienating…but if this work is to take root and be accessible, it can’t just happen in ‘math’ classes… especially in the younger grades… we have

to see the connections … you can see data science through the lens of english education/ digital humanities, within science education, within computer science, within physical education. The point being talking about the ways in which the concepts can be linked and connected to existing disciplines …and allow for small connections that build up as the writer above suggests, the learning progressions.

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At Literacy level (Data literacy)

- learners being able to understand the conceptual and contextual aspects of data as well as the process of data collection and application.
- awareness about the use and abuse of data for a given purpose; limitations of data as well
- understanding the “everydayness of data” (Stornaiuolo, 2020)

- *Competencies*: Being able to use technological and analytical tools
  - Being able to read a graph [Maybe graphical/data viz literacy even more generally] [We also can broaden/ make disciplinary connections to multimodal reading / sense-making here..]