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Knowledge in New Pieces: Exploring Modern Youth's Intuitive Knowledge

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Abstract: Youth's worlds are increasingly large, connected, and inextricably digital and analog. The intuitive knowledge that youth develop in navigating and constructing these worlds may similarly evolve in ways that could inform formal education. We present initial findings of a broader research program that studies what and how youth know about complex systems from their daily experience with them. Findings could guide the design of educational activities and curricula that leverage such knowledge in preparing youth for contemporary life.

Motivation and background

Youth's exposure to complex systems, natural phenomena, and forms of social interaction has increased dramatically. Some systems are technological; networked, internet-enabled, real-time processing devices are an inextricable part of youth's reality, making the gathering, processing, and flow of data as real a consideration as why the seasons change. Other systems arise in discourse; conversations about resource use, climate change, global economics, and systemic inequity and algorithmic bias, to name a few examples, are "in the air" more so now than ever. Youth inhabit and explore increasingly large, detailed, complex, and interconnected worlds.

This project is inspired by Knowledge in Pieces (KiP, diSessa, 1993) and its account of the diversity and contextuality of intuitive knowledge. KiP's *phenomenological primitives (p-prims)* capture small bits of intuitive knowledge about how things work (diSessa, 1993) (e.g., "forces act in balance," and "multiplication makes numbers bigger") that constitute the building blocks of sense making. This pilot is a first step in studying the novel, overlooked intuitive knowledge "pieces" - that is, the **knowledge in new pieces** (KiNP) - generated by youth's modern, techno-social lives. We are guided by the following research question: *what do youth know about complex systems based on their everyday, out-of-school exposure to such topics?*

This work could inform curriculum design and education in a few ways. diSessa's work tells us that learners do not simply "forget" typically unproductive p-prims (Smith III et al., 1994); they may be unaware that they regularly use a p-prim, and a given p-prim may remain productive in certain contexts. KiP also describes how, as learners' conceptual understanding matures, it develops into *coordination classes* (diSessa & Sherin, 1998) that highlight concept-relevant features and inform more consistent reasoning. We also base this work on research of how people think with and about technology (e.g., Danovitch & Severson, 2021; Turkle, 1984). We focus less on documenting youth's technology practices and instead seek to use the intuitive knowledge gained from those practices as a springboard for formal learning. Finally, we draw from *connected learning* in which, through community-supported pursuit of personal interests, youth learn knowledge and skills that can support their academic, civic, or career development (Ito et al., 2013).

Pilot methods

We collected several hours of video data with 5 youth aged 8-15. Using convenience sampling, all participants lived in major metropolitan areas, and 4 of the 5 youth had at least one parent with an advanced degree. Semi-structured interviews lasted 45 minutes and addressed topics drawn from the first author's 10+ years of informally talking with youth about technology (Table 1). Interviews were conducted on Zoom, automatically transcribed, verified by the second author, and collaboratively and thematically coded (Braun & Clarke, 2006).

Table 1
Sample interview topics and prompts

Topic	Interview Prompt(s)
1.Exponential Growth	How long would it take a great meme to get 100 views? 1,000 views? 1 million views?
2.Artificial Intelligence	How do AI assistants understand you and do what you want them to? If you got a different answer from an AI assistant and from an adult, whose answer would you trust?
3.Robotic Workforce	As robots advance, they do jobs that people used to do. People who had those jobs, what do they do now? What would you tell someone worried about being replaced?
4.Industrial Impacts	When you buy a t-shirt, what happened for it to be made and get to you?

Pilot findings

Related to ideas of exponential growth (Q1), participants identified a range of variables that affect content's view rate: number of followers, influence ("famous" or "regular" person), metrics (views or reactions), and timeliness ("in the news" or "just random"). Some participants offered sophisticated mathematical reasoning about exponential growth, characterizing powers of 2 before they were exposed to such concepts in school ("If you send it to 2 people, and those people send it to another 2 people, it keeps getting larger and larger").

About half the participants also offered detailed considerations of the environmental and human impacts of the clothing industry (Q4). They indicated an awareness of complex resource and supply chains as well as of the unintended consequences of industrial workflows: large plantations using land and water to grow cotton, factories using energy to spin thread and fabric and to sew fabric into shirts, stores selling the shirt, trucks using fuel to transport goods at every step. Participants also recognized the social, policial, and economic dynamics that shape those networks. One participant described such work as happening "in places like China, India. …because Americans don't have time for that" and discussed issues of cost of living ("maybe not good work, but it's a work that can provide enough"), wage theft ("there's some places that don't even pay their people"), labor relations ("the people who are actually in control … are less willing to pay [their workers] five times more."), and global economic dependence ("The work then gets shipped off to different countries … The country is completely dependent on that."). Another participant summarized these issues using an intuitive sense of ethical "balance:" "every time you're going to do good, you're also going to do evil." He discussed the impact of t-shirt production as a complex ethical dilemma, between generating jobs and low prices in some countries while destroying the environment in others.

We also found ways in which youth's previous knowledge about socio-technical systems was insufficient to sustain complex sensemaking. Most participants agreed that a social media post would continue to gain views indefinitely. Similarly, most participants expressed an understanding of AI as based on "very delicate coding" composed of endless if-then statements (Q2), likely the type of code they are familiar with from environments such as Scratch. Finally, all but one participant expressed no qualms about expanding robotic workforces (Q4). Participants were confident that replaced human workers could either become robotics technicians ("they could program the robots") or change careers ("there are a bunch of other jobs out there").

Conclusions

Our preliminary data suggest that youth indeed know some advanced knowledge pieces even without formal instruction on them, up to a certain limit. The topics addressed by the interview protocol are typically not yet taught in formal education to children of our participants' ages, suggesting our participants acquired these ideas through first hand experience with online content or through immersion in local or global public conversations. There is also great potential for educational designs and curricula to precisely address the missing pieces that are harder to glean from everyday experiences (e.g. balancing the novelty of technology with the ethics of its human implications). In expanding this pilot work, we aim especially to diversify our participant pool, including internationally, to access a wider range of youth perspectives (Kafai et al., 2010). We believe these preliminary findings justify further study of the "new pieces" of youth's intuitive knowledge. Educational designs and curricula that reflect and honor students' intuitive knowledge could better prepare them for life and civic participation in the 21st century.

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