Theoretical Framework: Visual Arts as a Path to Data Literacy

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BUILDING INSIGHTS THROUGH OBSERVATION

A Shift from Mathematical Thinking to Visual Thinking

Our theory is grounded in the reality that most people in society are ultimately consumers of visualized data created by scientists and data professionals. To apply data literacy outside of the science classroom, students need to be able to holistically interpret and evaluate (not just decode) visualizations of complex and messy data, in the context of making decisions about their own lives and work. Further, a data literacy definition cannot standardize a "correct" way of reading or interpreting data, as it masks the inherent subjectivity of data representations[1] and can be a barrier for student engagement and diverse ways of approaching information.

We propose that science education could benefit from the expertise of non-STEM disciplines, specifically visual arts education – a discipline centered on how learners engage with, make meaning from, and think critically about ideas in complex visual forms.

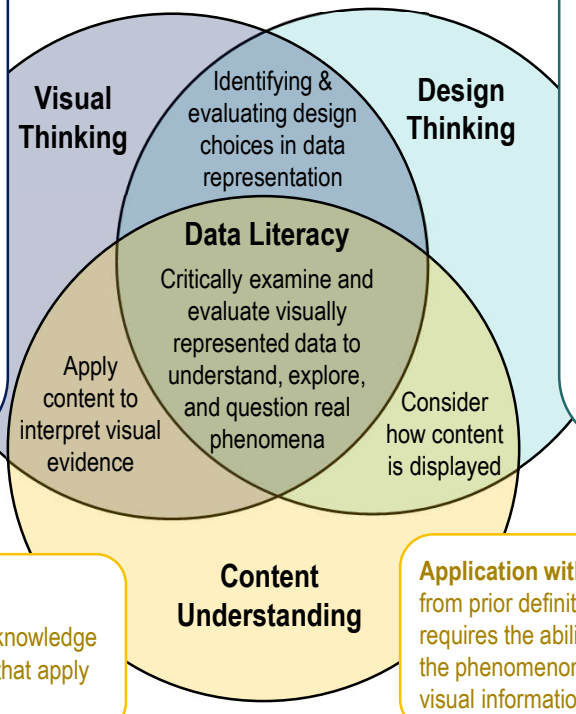
Research on the impacts of art education suggests that this field can develop important critical thinking skills, including observation, interpretation, comparison-making, and flexible thinking.[2-5] These are skills with direct parallels to those that have been explored in research on how to implement strong data literacy education.[6-12]

From a review of the literature and a year of curriculum co-development and testing with middle school teachers,[13] we developed a new conceptual framework for data literacy consumers. We built upon a Venn diagram model that positioned data literacy as the intersection of several skills with scientific conceptual understanding.[14] But we replaced the original framework's mathematical and computational thinking skills with visual thinking and design thinking. **In the diagram below, we define each component and why it matters for building literate consumers of complex data.**

Visual Thinking

What is it? Skills to look critically at a visual representation and interpret meaning through a logical framework using visual evidence and broader knowledge.

Application to data literacy? With visual art, learners get beyond simple observations or fanciful stories. Using visual thinking, interpretations are supported with observed visual evidence. Moreover, strong visual thinkers are open to multiple possible interpretations and evaluate diverging conclusions based on the evidence.[3,15-16] These skills align with what is needed by a strong data consumer.



Design Thinking

What is it? Skills to recognize design, layout, and symbology choices in a visual work, and to iterate and problem-solve around affordances and limitations of available choices.

Application to data literacy? Visualized data are inherently abstractions of information, and no representation of data is objective; its creators have made choices that influence what is highlighted and minimized.[17-18] The skills used in design thinking enable a learner to recognize those design decisions, evaluate their strengths, and iterate on other options and how they would modify the solution or presentation.[19]

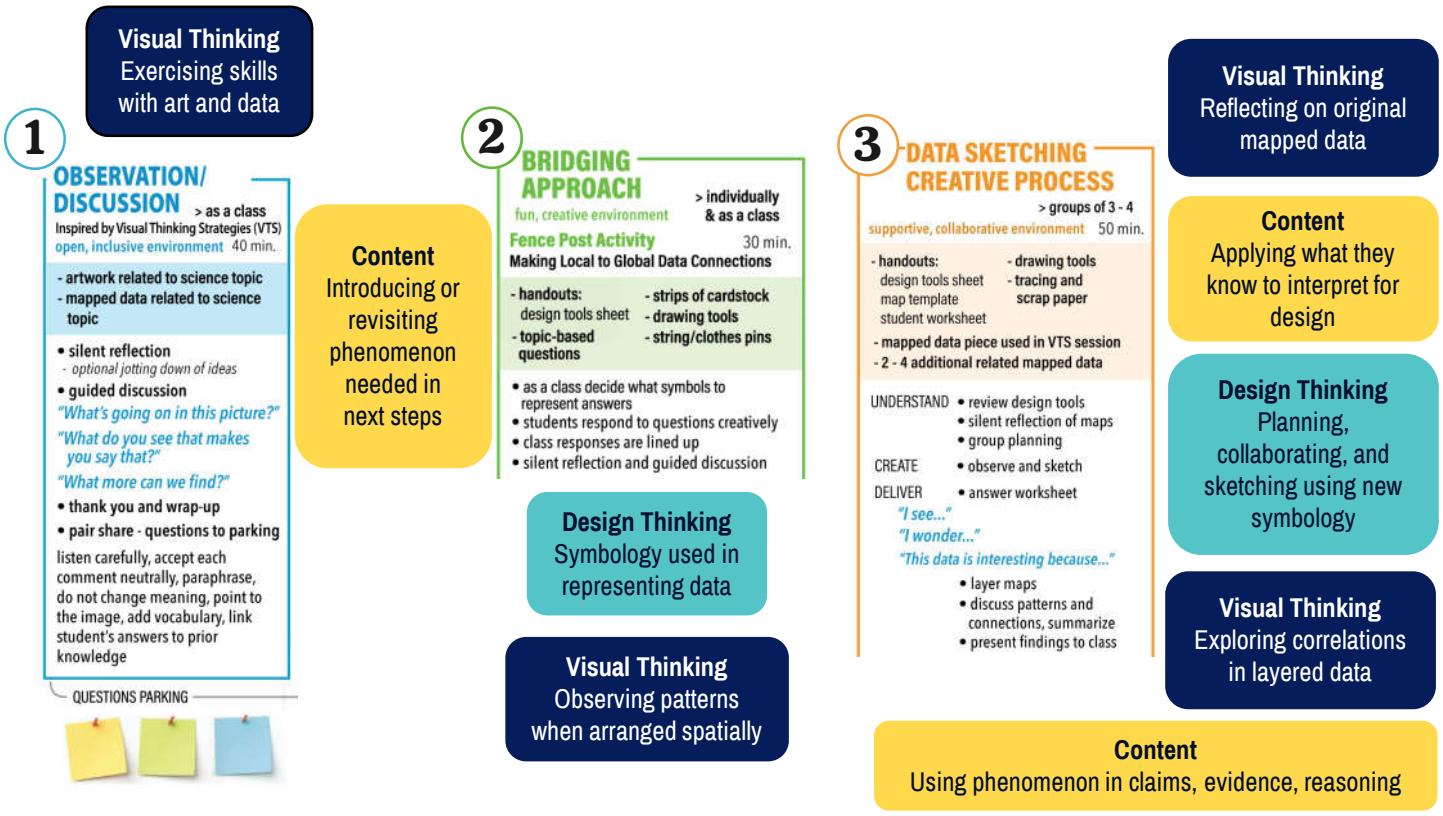
Content Understanding

What is it? Existing or acquired knowledge about concepts and phenomena that apply to visual information.

Application with data literacy? This is maintained from prior definitions of data literacy.[16] Data literacy requires the ability to apply what one knows about the phenomenon and contextual factors with the visual information.

Applying the Theory: Building Insights through Observation Teaching Framework

The Building Insights through Observation teaching framework has three core components: (1) Visual Thinking Strategies Discussions; (2) Fence Posts; and (3) Data Sketching. In tandem, these three components give students opportunities to practice and interweave all three of the core skills for data literacy from our theoretical framework – visual thinking, design thinking, and content understanding – using art, design, and geospatial data visualizations. The diagram below illustrates how and when the different skills are applied.



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