Thinking with Data

Not long ago, the information people needed for decision making was simple and at hand. Today, as life continues to grow more complex, information is becoming more pervasive and ambiguous than ever. Therefore, success in learning and in life requires an understanding of how to effectively interpret and use data.

As consumers, we use data in our everyday lives—to choose medications or health practices, to decide on a place to live, or to make judgments about education, policy, and practice. As literate citizens of a democratic society, we are called upon to reason and interpret data intelligently. The newspapers and TV news are full of data about nutrition, side effects of popular drugs, and polls for current elections that we need to interpret intelligently. To think with this data, we must judge the reliability of what we read, see, and hear, and make critical and subtle distinctions as we think about the data that is thrown our way (Rubin, 2005).

Importance of Thinking with Data

Through the Internet and other mass media, 21st century citizens have access to almost unlimited amounts of data on an endless number of topics. Authentic experiences using real data in the classroom prepare students to use data effectively and responsibly in their lives.

Skills Used in Thinking with Data

Thinking with data is a specific type of thinking that includes many 21st century skills, particularly problem solving, critical and systems thinking, creativity, and communication.

Thinking with Data in the Classroom

Students learn to think with data, first, by working on projects that require the collection, analysis, and interpretation of data.

Children in junior primary school can develop basic skills in collecting and analyzing data. For example, in Meet the Bears, Year Two students look at bears from all angles to answer the Essential Question, *Are we like other animals?*

After a car and pedestrian accident occurs near the local school, concerned Year Five students, parents, and neighbors collect and interpret data to launch a neighborhood safety project in Red Light, Green Light.

Using actual wildlife injury data from a local wildlife rescue center, middle years’ students learn what animal species have been injured and the causes of injury in What Happened to Robin?

Examples of Unit Plans that Incorporate Thinking with Data

- Meet the Bears
- Red Light, Green Light
- What Happened to Robin?
- Track the Trends
In *Track the Trends*, senior secondary students take on the role of statisticians by choosing a subject of interest and collecting statistical information about the subject over time and predict the implications of their findings.

**References**


Importance of Thinking with Data

Without an understanding of how samples are taken and how data is analyzed and communicated, one cannot effectively participate in most of today’s important political debates about the environment, health care, quality of education, and equity (Konold & Higgins, 2003). The educated and ethical use of data can focus critical conversations on generalizations derived from concrete information, rather than on isolated incidents and personal opinions.

Individuals who are proficient at collecting and interpreting different kinds of data have tools at their disposal to help them make good decisions in all aspects of their personal and political lives. Community organizations, for example, collect data about current and potential members in order to develop projects that most effectively meet the needs of their constituents. In their personal lives, individuals compare prices and features of products and services, investigate medical treatments, and make financial decisions.

Many careers now require an understanding of how to collect and use data effectively. For example:

- Farmers and agribusinesses use crop forecasts and the results of agricultural field trials.
- Engineers are concerned with data on product performance, quality, and reliability.
- Manufacturing workers are increasingly asked to record and act on data for process control.
- People in the health sciences field struggle with data on cost and effectiveness as well as with data from medical research.
- Business runs on data of every variety: costs, profits, sales projections, market research, and much more (Moore, 1990).

We live in the information age—an age in which we are bombarded every day with data. News reports present national economic and social statistics, opinion polls, medical data, and business and financial data. For students to make sense of all these messages and to use data responsibly to persuade and communicate with others, thinking with data must be an integral part of the classroom experience.
Skills Used in Thinking with Data

Thinking with data is a specific type of thinking that includes many 21st century skills, particularly problem solving, critical and systems thinking, creativity, and communication. Thinking with data also frequently involves collaboration and self-direction.

Students who think with data engage in multiple complex thinking skills. These students:

- Analyze, interpret, and make sound inferences from data
- Extract implications and conclusions from data
- Create and apply criteria to gauge the strengths, limitations, and value of information and data in productive ways
- Form and communicate conclusions that are based in evidence and statistical literacy

In the context of a fast-paced, knowledge-based society, thinking and reasoning with data requires both divergent and convergent thinking.

_Divergent thinking_ requires creativity to answer the question, "What if?" In divergent thinking, students establish multiple scenarios and ideas that they can consider when they create statistical questions to pursue, or analyze and make inferences about data. It encourages students to look at data from various viewpoints.

_Convergent thinking_ enables students to use sound reasoning and common sense to analyze data from multiple perspectives. This type of thinking allows students to select the statistical question with the most potential based on a set of criteria.

Thinking with data is not a single event. In fact, thinking with data can be thought of as a five-stage process:

1. Forming a solid statistical question
2. Collecting appropriate and unbiased data
3. Analyzing and interpreting data
4. Evaluating and synthesizing data
5. Forming and communicating conclusions (Friel & Bright, 1998)

Thinking and reasoning intelligently about data moves students beyond the graphing and data-collection skills that they typically experience in classrooms (Konold & Higgins, 2003). Students also need to develop proficiency in communication, collaboration, and reasoning skills.
Thinking with Data in the Classroom

Data is more than just numbers, and thinking with data is not limited to mathematics. Data can be observational records or interviews as well as statistical information. Thinking with data is an important component of all subject areas. Whether students are conducting historical research on their neighborhood, analyzing the demographic trends of their school, or interpreting a work of literature, students must think systematically about different kinds of evidence and draw conclusions about what they have discovered. They must also communicate their methods and their findings to others. Students can apply data analysis tools in all their classes and in their lives to create models to describe and reason about real-world situations.

Students learn to think with data, first, by working on projects that require the collection, analysis, and interpretation of data. They need opportunities to practice their skills in a variety of contexts throughout the day. Research is clear, however, that mere exposure to tasks that require this kind of thinking does not on its own have a significant impact on students’ thinking abilities (Beyer, 2000; Swartz, 2000). Those skills must be taught through modeling, guided practice, and training.

When students work on projects that require thinking about and with data, teachers must identify the specific skills students will need to exercise at different stages of the project. These skills, such as identifying patterns, drawing conclusions, and communicating mathematical processes, can be taught through modeling the skills and strategies necessary to complete specific tasks. As students use their new skills to work with data in meaningful projects, teachers assess their proficiency informally, and follow up when necessary with additional instruction and modeling.

In classrooms where thinking with data is a regular part of instruction, students and teachers question their conclusions by asking questions:

- What evidence supports your point of view?
- Where did you find this evidence?
- Do you have all the relevant evidence?
- What methods did you use to reach your conclusions?
- Why did you interpret the facts the way you interpreted them?

When this kind of thinking becomes part of regular classroom processes, students learn to see thinking with data as a tool that can help them make informed decisions.