Definitions of Data Literacy Skills
Based on Mandinach and Gummer, 2016a, 2016b

Identify Problems and Frame Questions
- *Articulate a problem of practice* about a student, group of students, a topical area, the curriculum, or an aspect of instruction. Teachers should be able to identify the problem and explain the issue or question.
- *Understand the context at the student level* to understand the problem with a student or a group of students. By contextualizing the learning, behavioral, or motivation issues students may be having, teachers will better understand the situation, will more accurately identify the problem, make a decision to address the problem, and follow through on subsequent action.
- *Understand the context at the school level.* This is a different level of aggregation from student level context. Understanding the larger context of a school in which teachers' practice is embedded provides a broad view toward seeking solutions to problems of practice.
- *Involve other participants or stakeholders*, including students. Other educators, parents, and students can provide valuable insights into students' performance. Consultation with them is an important part of the decision-making process.
- *Understand student privacy.* It is increasingly important for teachers to understand the regulations around the protection of student privacy and confidentiality. This skill set includes, among other topics, knowing how to discuss data and with whom and understanding data sharing.

Use Data
- *Understand assessment.* Teachers need to understand what makes a sound assessment. They must understand the different kinds of assessments, their purposes, and their uses.
- *Develop sound assessment design and implementation.* Teachers must be able to develop assessments whether by hand or through the use of assessment systems. This set of knowledge and skills entails knowing how to design items and combine them into a meaningful test that yields reliable and valid data.
- *Understand data properties.* Data have characteristics and qualities that teachers need to understand and have alignment with the purposes of data use. Data have different levels (e.g., total score, composite, strand, item-level) and these levels may be more appropriate for different questions.
- *Use qualitative and quantitative data.* Most educators think of data as numbers that can be quantified. Data are much more. It is important to recognize that not all data are quantitative and that qualitative indices can be valuable and informative sources.
- *Understand specificity of data to question/problem.* Teachers must have the knowledge and skills to understand that some data can address the issue being examined, while other data will not.
- *Understand statistics and psychometrics.* Teachers must have a fundamental knowledge of basic statistics and principles of measurement. By statistics we mean simple statistics such as central tendency and dispersion. By psychometrics we mean understanding topics such as reliability, validity, and error of measurement.

- *Identify possible sources of data.* Teachers must be able to evaluate the right data for the particular problem of interest, data that are aligned at the problem of practice and actionable.
- *Understand the purposes of different data sources.* Teachers must understand the purpose of different data because different data have different uses and utility.
- *Use multiple measures/sources of data.* This is a foundational concept in data-driven decision making and educational measurement. It is important not to rely on just one measure but to triangulate among multiple sources of data to obtain a better and more accurate depiction of the situation.
- *Understand how to generate data.* Generating data is important because not all data are already produced. Teachers generate a plethora of data every day, ranging from moment to moment assessments of students to more long-term determinations of students' understanding.
- *Understand how to analyze data.* Teachers must understand what the data mean. Analyzing data enables the user to understand what the data mean, whether qualitative or quantitative. Analysis is one of the most foundational skills in data literacy.
- *Prioritize data* because not all data are as relevant or as important as others. It is therefore important to arrange the data according to the utility of the issue being addressed.
- *Integrate data* by examining, analyzing, and combining them in some meaningful way for sense making.
- *Examine data.* Data examination means to scrutinize or inspect data in a meaningful way to address a particular question, hypothesis, or issue.
- *Manipulate data.* Data manipulation entails handling or treating the data as part of the examination process.
- *Organize data* into a meaningful and manageable representation of the information.
- *Manage data.* Teachers must know how to manage data because there is such a multitude of data. The wealth of data must be handled with accuracy, coded, stored, and arranged in a coherent manner for latter access and examination.
- *Drill down into data.* Total test scores do not tell the complete story. Teachers need to drill down to strand or item levels to really understand misconceptions and understandings.
- *Aggregate data.* Teachers must understand that there are times when looking to whole group data is important.
- *Disaggregate data.* Teachers must understand the need to examine subgroup differences. They must know how to break down data into subgroups to discern differences across group performance.
- *Use formative and summative assessments.* Teachers must know how to use both formative and summative assessments, including understanding when which sources of data are appropriate for instructional purposes versus assessment/grading purposes. This type of decision making is a key skill for teachers. Different sources of data yield different kinds of information that may be more or less aligned to instructional practice.
- *Understand data quality.* Data quality has many aspects such as validity, timeliness, and consistency of the data. Foundational to data use is knowing that the data being used are "clean," timely, and valid for the purposes of use and interpretation. Data must not be misleading or out of range; that is, if the highest score possible is 100 and a score is entered as 110, teachers must recognize that there is a problem.

- *Understand elements of data accuracy, appropriateness, and completeness.* This is a subskill from the more general one about data quality. Data must be accurate. They also must be appropriate to the problem of practice or the question being addressed and as complete as possible. Using data that lack any of these qualities can invalidate the conclusions drawn from the data collection and analysis process.
- *Understand what data are appropriate.* Teachers must be able to understand that not all data are appropriate or applicable for every given circumstance. It is important to recognize when specific data are or are not relevant for the problem at hand.
- *Understand how to access data.* Teachers must know how data are stored and made available. They must be able to navigate across multiple data systems. Increasingly, educational data are stored in electronic formats for easy and safe access and analysis. Note that accessing data is different from generating data. The former entails data retrieval. The latter entails the actual creation of data.
- *Find, locate, access, and retrieve data.* Teachers must have the ability to locate the data needed to address a problem of practice or educational question and be able to pull out those data for subsequent examination.
- *Use technologies to support data use.* Teachers must know how to use technologies to support data use through data warehouses, assessment systems, student information systems, instructional management systems, data dashboards, spreadsheets, applications, and other relevant technologies that provide access to, analysis, and reporting of data.

Transform Data into Information
- *Consider the impact and consequences* because the outcomes of the inquiry process and decisions made based on that process have consequences which can be either expected or unexpected.
- *Test assumptions* early in the inquiry cycle to help determine if teachers are on the right track or off target.
- *Generate hypothetical connections to instruction.* Teachers must foresee how what they plan to do instructionally fits into the flow of students' learning and progress. To do this, they must know how to project hypothetically and consider what will happen if they take various courses of action. This is based on educated guesses about why things are happening the way they are and what might happen with different instructional steps.
- *Understand how to interpret data.* Teachers must know what the data mean. Interpretation gives meaning to the data and provides explanations.
- *Predict possible or likely consequences.* Teachers need to consider what the outcome of their actions will be.
- *Understand and use data displays and representations.* Teachers need to know how to use data displays because data are often graphically depicted, in charts, tables, graphs, and other displays.
- *Assess patterns and trends.* Teachers must be able to discern patterns and trends from data, especially when data are displayed in charts and graphs.
- *Summarize and explain data* to pull together an explanation of what the data and information mean.
- *Synthesize diverse data.* Teachers must know how to synthesize diverse data. Disparate data are often applied to a problem and must be pulled together in a coherent manner in order for them to make sense.

- *Probe for causality,* as an attempt to understand why the behavior, performance, or situation has happened.
- *Use statistics.* Teachers must be able to use simple statistics such as central tendency and dispersion to understand student performance.

Transform Information into a Decision
- *Understand the context for the decision.* Teachers must understand the setting into which their decision is being fit. This includes knowing about the content, the curriculum, the scope and sequence, and other classroom contextual information.
- *Determine next instructional steps.* Based on the evidence that teachers have acquired, they must use those data to plan and determine what are the next logical steps to take instructionally.
- *Monitor student performance.* Teachers need to be able to watch student performance over time to determine if differences have occurred or changed behavior.
- *Diagnose what students need.* Teachers must know how to determine students' learning strengths and weakness from performance over time.
- *Make instructional adjustments.* Teachers must know how to make instructional adjustments based on data they have at hand. This means knowing what instructional actions are appropriate given the information gained from examining data.

Evaluate Outcomes
- *Consider the need for iterative decision cycles*. Fundamental to the decision making process is the notion of iterative cycles of inquiry. This means that decisions do not have an end point. Data are collected, analyzed, interpreted, and acted upon. Then the cycle begins anew. Teachers must recognize the iterative nature of the teaching and learning process.
- *Re-analyze the original question or problem.* Teachers must recognize the need to look back at the original problem or question to determine if the data and decision have addressed the original issue and what steps need to occur informed by that re-evaluation.
- *Compare performance pre- and post-decision.* Part of the inquiry process is checking to see if there has been a change from before a decision was made and action taken to afterwards. This is to determine the impact of that decision-making process.
- *Monitor student changes in performance.* Teachers must observe changes in their students following a decision to determine if the decision and ensuing intervention has had the desired effect.
- *Monitor changes in classroom practices.* Part of evaluating the outcomes is observing what has happened in the classroom based on the actions taken from the decision. Teachers must continue to be aware of the changes to determine if they have been in the desired direction.

Dispositions, Habits of Mind, or Factors that Influence Data Use
- *Belief in data/think critically.* Teachers need to believe in the use of data, that data can help them do their jobs more effectively and to think deeply about the problem at hand while using the inquiry cycle to use data to inform a decision.
- *Belief that improvement in education requires a continuous inquiry cycle.* Improvement is a continuous cycle of tweaking things to see if they work, observing outcomes, and

making modifications as needed. Teachers need to understand that their work is not a linear, cause-and-effect process, but a cyclical and ongoing process.

- *Ethical use of data, including the protection of privacy and confidentiality of data.* Of the utmost importance is the knowledge about how to protect student data in terms of privacy and confidentiality. Teachers must understand the fundamental ways to use data securely and responsibly.
- *Collaboration (vertically and horizontally).* Collaboration is considered an important and valued component in the inquiry process where educators work together, across grade levels and in grade level teams, to examine data and seek solutions to a particular problem.
- *Communication skills with multiple audiences.* Teachers must be able to discuss results and performance with various audiences, using empirical evidence in the discussion. Audiences include students, parents, guardians, other educators, and other relevant stakeholders. They must be able to adapt their communication to the particular audience.

For additional information about Data Literacy for Teachers, please see:

Mandinach, E. B., & Gummer, E. S. (2016a). *Data literacy for educators: Making it count in teacher preparation and practice*. New York, NY: Teachers College Press.

Mandinach, E. B., & Gummer, E. S. (2016b). What does it mean for teachers to be data literate: Laying out the skills, knowledge, and dispositions. *Teaching and Teacher Education, 60,* 366-376.