From Data to Impact: A Guide to Strengthening STEM Education

TEA Texas Education Agency

Intended Audience

This guide is intended for school systems' data team members, including teachers, leaders, instructional coaches, and other educators responsible for analyzing data and supporting continuous improvement in Science, Technology, Engineering, and Mathematics (STEM) education.

Purpose

From Data to Impact: A Guide to Strengthening STEM Education is a resource designed to support data teams in using data to inform and strengthen STEM instruction. Data-driven instruction relies on both qualitative and quantitative data to identify trends, assess student needs, and guide instructional decision-making. By using data to inform planning and continuous improvement efforts, educators and leaders can design meaningful STEM learning experiences, respond effectively to challenges, and implement instructional practices that support student success. Through a systematic approach to data analysis, data teams can establish priorities, set measurable goals, and make informed decisions that improve teaching and learning outcomes.

Section 1: Understanding STEM Data

Begin with Needs

When developing goals for STEM instruction, data teams should begin by gathering and analyzing data to better understand their current educational context and student performance trends. Mathematics and science achievement data provide valuable insights because they are measured through a variety of assessments administered at both the state and local levels. Data related to technology, engineering, and STEM fluency skills, however, are often derived from local formative and performance-based assessments.

Using multiple data sources helps educators gain a comprehensive understanding of student learning and identify opportunities for program improvement. By analyzing trends, strengths, and areas of need, school systems can make informed decisions that support continuous improvement in STEM education.

Consider the following recommendations when identifying opportunities for growth within a school system's STEM program:

- Gather data from multiple sources to develop a comprehensive understanding of student performance. State assessment results, classroom-based formative and summative assessments, and performance-based measures can provide valuable information for analysis and comparison.
- Analyze data to identify gaps between current performance and desired outcomes. These gaps often reveal opportunities for targeted improvement and may highlight disparities in student achievement.
- Prioritize areas of need by focusing on a limited number of high-impact opportunities for growth. In many cases, these will be the lowest-performing content areas, practices, or skills.
- Establish measurable goals that address identified needs and support improved outcomes for students.

This process helps data teams use evidence to guide decision-making, allocate resources strategically, and develop focused STEM improvement efforts that meet the needs of all learners.

Assessment Types and Data Sources

Data is a valuable tool for improving STEM teaching and learning. Various assessment types generate data that can be used to identify trends, monitor student progress, and inform instructional decisions. To gain a complete understanding of student learning, educators use multiple measures, including summative, formative, and performance-based assessments.

Summative STEM Assessments	Formative STEM Assessments	Performance-based STEM Assessments
• Occur often at the end of an instructional sequence (summative)	• Occur in real-time during an activity or lesson	• Can occur over time or in real-time during a project
• Assess a range of cognitive skills, from recall and recognition to application and analysis, depending on the assessment design	• Include a variety of low-level, mid-level, and high-level skills	• Call for the application of knowledge and skills, not just recall or recognition
• Are snapshots of the degree of content proficiency in specific subject areas	• Are snapshots of the degree of content and skill proficiency in specific subject areas	• Are open-ended and typically do not yield a single, correct answer
• Target specific skills or tasks in a concrete, singular fashion	• Can target specific content or skills in either a concrete, singular fashion, or a more complex fashion	• Establish novel and authentic contexts for performance
• Measure the acquisition of knowledge	• Measure the acquisition of knowledge and skill	• Provide evidence of understanding via transfer
• Rely on norm-referenced measures	• Elicit and identify student misconceptions	• Can integrate two or more subjects as well as STEM fluency skills
• Are evaluated by the number of correct answers	• Assess each student individually or assess a group or class	• Can be used to evaluate both processes and products
• Assess each student individually		• Are evaluated with established criteria and rubrics
Examples of Summative Assessments and Uses	**Examples of Formative Assessments and Uses**	**Examples of Performance-based Assessments and Uses**
State-level assessments (Beginning-of-Year, Middle-of-Year, and End-of-Year) and short-cycle assessments (recent content assessments) **Used to assess:** • All content knowledge (EOY) or TEKS within a recent unit **Item types might include:** Multiple-choice, fill-in-the-blank, true or false, matching, short-answer, or writing examples	KWL chart, bell ringers, exit tickets, concept maps/graphic organizers, claim-evidence-reasoning, learning logs, attitude surveys, peer and self-evaluations, discussion, informal observation, conference, journal entry, quiz, product, etc. **Used to assess:** • All content knowledge • Content practices • Integration of technical skills and tools	Portfolios, journals, peer/self-assessments, discussions, observations, extended responses, model development, presentations, or other evidence demonstrated throughout a process or task, etc. **Used to assess:** • STEM content knowledge and practices • Experimentation • STEM fluency skills • Application of STEM and non-STEM content and skills in authentic contexts

Section 2: Analyzing STEM Data

Application of Data in STEM

Data-driven instruction is most effective when informed by multiple reliable data sources that provide a comprehensive picture of student achievement. In STEM education, analyzing data trends across grade levels and courses supports vertical alignment and continuous improvement.

Summative STEM Assessments	Formative STEM Assessments	Performance-based STEM Assessments
Summative and other local or classroom-based assessments can help identify instructional focus areas to guide STEM curriculum development. Targeted STEM learning experiences support growth in specific content knowledge and skills identified through assessment data.	Formative assessments provide timely insight into student understanding, thinking, and misconceptions throughout a STEM learning experience.	Performance-based assessments measure the application of knowledge and skills during STEM learning experiences.
Texas state-level assessments include annual assessments in: • Reading and mathematics • Writing • Science • Social studies • English I, Algebra I, Biology, and U.S. History (End-of-Course (EOC) assessments)	**Formative assessments:** • Assist teachers in monitoring student learning through quick checks. • Provide students with ongoing feedback to improve performance. • Help students identify strengths and areas for growth. • Help teachers identify learning gaps and address challenges promptly.	**Examples include assessment of:** • Student planning and implementation of scientific investigations during scientific inquiry. • Students' engineering design processes and products during engineering design challenges. • Student thinking, problem-solving, design thinking, and STEM fluency during problem- or project-based learning and design challenges.
State-level assessments measure student understanding of the Texas Essential Knowledge and Skills (TEKS) and provide an annual snapshot of student achievement. Data can help identify trends and monitor proficiency across STEM-related disciplines. Because state assessments are not administered at every grade level or in every course, formative and performance-based assessments are also needed to provide ongoing, discipline-specific information about student learning.	**Both Formative and Performance-based Assessments**	Formative and performance-based assessments provide data that can inform integrated STEM learning experiences, such as scientific inquiry, engineering design challenges, and problem- or project-based learning. Assessment data helps educators identify strengths, learning needs, and misconceptions and design targeted opportunities for students to deepen their understanding of challenging concepts and skills.

Assessment Example Within an Integrated Unit

Using a combination of state-level assessment data, short-cycle assessment data, and teacher formative assessments, a data team concluded that three knowledge areas of growth were:

- Mathematics: measurement (elementary science, ES); proportionality (middle school, MS); linear functions (high school, HS)
- Science: forces on an object (ES); average speed (MS); acceleration versus time graphs (HS)
- English Language Arts and Reading (ELAR): composition (ES, MS, HS)
- Social Studies: science, technology, and society (ES, MS, HS); historical events and factors that have impacted contemporary societies (MS)

Through formative assessments, the data team also realized that students needed to improve specific subject-area skills:

- Mathematics: data analysis (ES); graphing data (MS); communicating mathematical ideas (HS)
- Science: design and implement experimental scientific investigation (ES, MS, HS)
- ELAR: oral language (ES, MS, HS)
- Social Studies: critical-thinking skills to organize and use information acquired through established research methodologies from a variety of valid sources, including technology (ES, MS, HS).

Using this data, the data team developed an integrated STEM project that incorporated the target areas and skills in math, science, ELAR, and social studies. This project included opportunities for students to engage in both scientific inquiry and engineering design, as well as to incorporate other non-STEM content areas such as ELAR and social studies.

Integrated STEM Project:

Inquiry—

- Students engage in research inquiry to develop background knowledge about floating water vessels. Historical contexts might include the sinking of the Titanic, the economic impact of boats and their use in trade, how boats changed over time as a form of technology, and how boats relate to the culture of various populations (social studies, ELAR, technology)
- Students engage in scientific inquiry investigations to test a variety of boat shapes, boat materials, buoyancy, aerodynamics, hydrodynamics, etc. (science, mathematics)

Engineering Design—

- Students use their newfound knowledge and the engineering design process to develop and create water vessel prototypes that can float and move across a body of water (ES) with the highest rate of average speed possible (MS) or with the greatest amount of positive acceleration (HS). (science, mathematics, technology, engineering)

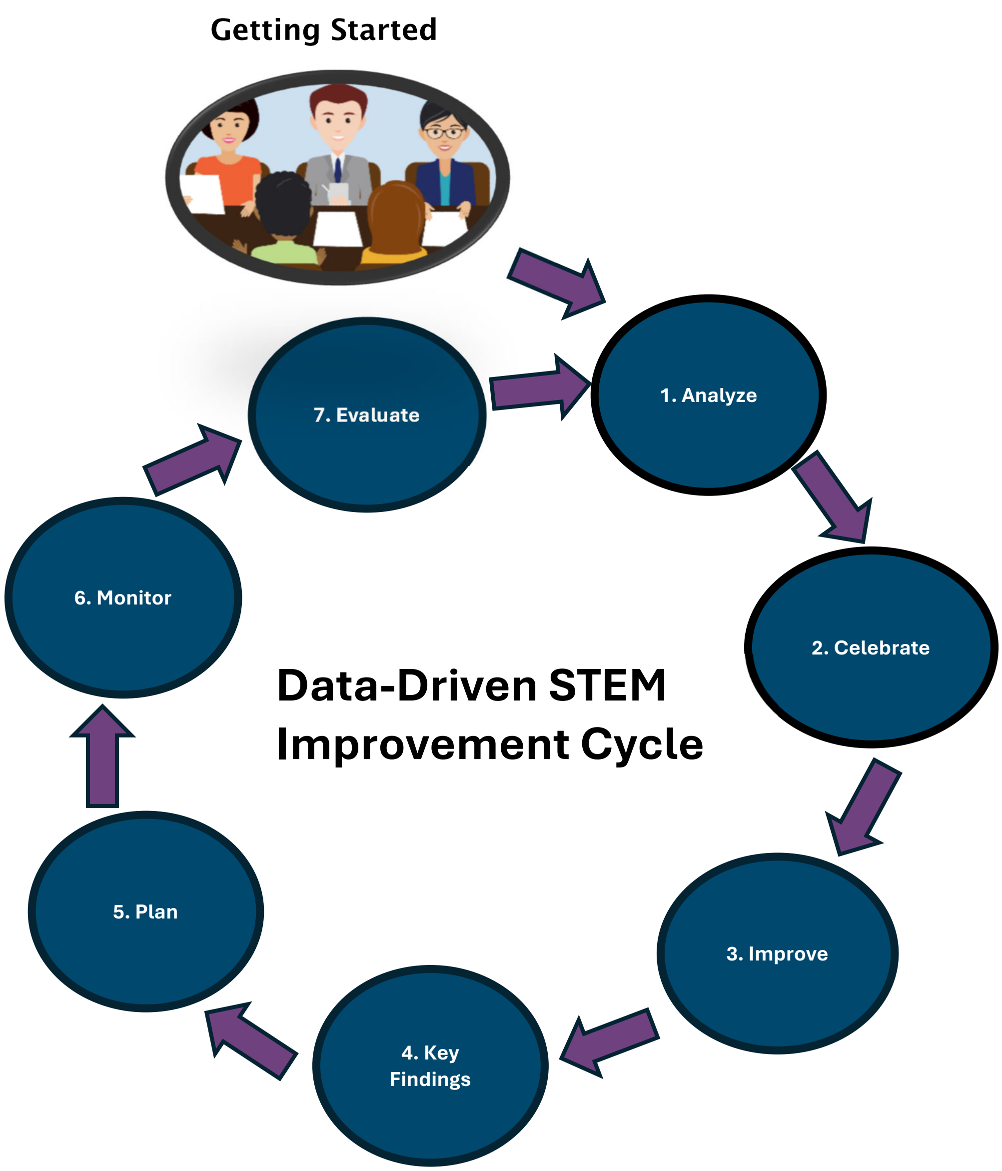
Communication—

- Students present a written proposal and a verbal persuasive pitch of their prototype designs to a panel of potential investors using data and graphs from prototype testing and other visual representations. (ELAR, social studies, mathematics, science, technology)

The teachers then used various performance-based assessments to assess students during the inquiry process, the engineering design process, prototype proposal writing, and a verbal persuasive pitch.

Examining STEM Data

Professional learning communities and data teams use data to identify strengths, areas for growth, and student needs and to inform instructional and curricular decisions. Collaborative data analysis supports deeper understanding and more effective planning. The following chart illustrates an iterative process for data collection, analysis, action, and reflection.



Data-Driven STEM Improvement Cycle

The following process supports data teams in analyzing data to identify strengths, areas for growth, and problems of practice. A facilitator may guide the discussion by reviewing norms, assigning roles, providing an overview of the data, posing guiding questions, and addressing clarifying questions as needed.

Getting Started—Overview of Data

What aspects of the data stand out? Focus on evidence rather than interpretations or opinions. Begin with individual observations, then discuss findings as a group. This step focuses on describing what the data shows without drawing conclusions or making recommendations.

Consider the following:

- Identify areas of interest.
- Highlight strengths and areas for growth in content knowledge and skills.
- Look for patterns or trends across content areas and skills.
- Note surprising or unexpected results.

Example of Guiding Questions:

Level	Summative	Formative	Performance-based
Elementary School	• Which concept had the lowest performance? • Which concept had the highest performance? • How do results compare across the past three years?	• What misconceptions emerged during the class discussion?	• To what extent were students able to gather and analyze data during the engineering design challenge?
Middle School	• Which grade 6 concepts had the lowest performance on the common assessment? • Based on state-level results, was there a strand that was low-performing in both grade 5 and grade 8?	• What evidence from the exit ticket indicates students' understanding of the targeted learning goal?	• What evidence in the engineering design portfolios demonstrates mastery of key concepts and skills? • What evidence indicates areas requiring additional support or instruction?
High School	• What percentage of grade 8 science students achieved Meets Grade Level or Masters Grade Level on the state-level assessment, indicating readiness for high school science?	• What does the content quiz reveal about student understanding? • Which concepts require additional instruction or support?	• What evidence from students' models and verbal explanations demonstrates an understanding of the concept?

Step 1—Analyze

What does the data tell the data team? What does the data not tell the data team?

- Begin with individual observations and then discuss findings as a group.
- Examine the data for patterns, trends, relationships, and possible implications for student learning.
- Distinguish between observations, inferences, and assumptions.
- Support all statements with evidence from the data.

Examples of Guiding Questions:

Level	Summative	Formative	Performance-based
Elementary School	• What factors may have contributed to students not meeting proficiency expectations?	• What misconceptions emerged through student questions, discussions, or assessment responses?	• To what extent did students demonstrate the ability to collect, organize, and analyze data during scientific investigations?
Middle School	• Was the objective or learning target taught during the current grade level, or was it introduced in a previous grade level?	• What factors may be contributing to students not meeting grade-level expectations?	• What evidence from student portfolios demonstrates growth in content knowledge, scientific and engineering practices, or application of skills?
High School	• How does the summative data compare with other sources of student data? • Are students demonstrating mastery on classroom assessments but performing differently on campus-based or state assessments? • Are there discrepancies among assessment results that warrant further investigation? • What additional information is needed to better understand student performance?	• What misconceptions or gaps in understanding are evident in students' performance? • How is the content typically taught (e.g., direct instruction, laboratory investigations, manipulatives, collaborative learning, or independent practice)? • How might instructional approaches influence student understanding and performance?	• What trends or patterns in student portfolio data provide insight into student learning? • To what extent did students support their conclusions with appropriate claims, evidence, and reasoning? • What strengths and areas for growth are evident in students' use of claims, evidence, and reasoning? • How might literacy skills influence students' ability to communicate scientific understanding through written responses, lab reports, or presentations?

Step 2—Celebrate

What successes are evident in the data?

- Identify and share evidence of student, classroom, grade-level, or programmatic successes.
- Highlight areas of growth, improvement, and strong performance.
- Consider trends, patterns, and practices that may be contributing to positive outcomes.
- Discuss how these successes can be sustained and replicated.

Examples of Guiding Questions:

Level	Summative	Formative	Performance-based
Elementary School	• Which grade-level content areas or courses are performing above expectations? • Which mathematics or science TEKS demonstrate the highest levels of student achievement?	• What prior knowledge do students demonstrate about the content based on the assessment tool (KWL, bell ringer, concept map, etc.)?	• Based on students' scientific inquiry investigation documentation, which scientific investigation or engineering design challenges and STEM fluency skills demonstrate the highest levels of mastery?
Middle School	• What strengths are evident among students who are meeting or exceeding grade-level expectations? • What instructional practices, programs, or supports may be contributing to these positive outcomes?	• Which concepts demonstrate the highest levels of student proficiency based on quiz results? • What connections among concepts are evident in student-created materials? • How effectively are students demonstrating their understanding of relationships among key concepts?	• Do project-based learning (PBL) portfolios or engineering design notebooks demonstrate strong evidence of student mastery? • What patterns in student work provide evidence of content mastery or STEM fluency skills?
High School	• Which student groups, classrooms, courses, or content areas demonstrate strong performance? • What patterns in the data indicate sustained growth or improvement over time?	• What strengths and misconceptions are evident in students' assessments? • What patterns in the data provide insight into students' background knowledge and conceptual understanding?	• What evidence demonstrates students' ability to apply knowledge and skills from multiple disciplines? • Which STEM practices are students demonstrating consistently throughout the design or inquiry process?

Step 3—Improve

What areas for improvement or problems of practice are suggested by the data?

This step helps the data team identify connections among strengths, gaps, and opportunities for growth. Focus on instructional practices, systems, and supports that can improve student learning and outcomes in STEM.

Examples of Guiding Questions:

- What actions are most likely to improve student outcomes in this area?
- Which instructional practices could be strengthened or adjusted to support student learning?
- What are the data team's next steps?
- What additional data, evidence, or artifacts should be reviewed to better understand the identified needs?
- What patterns in classroom instruction, student work, or assessment results warrant further investigation?
- What professional learning may be needed to support improved student outcomes (e.g., content knowledge, instructional practices, vertical alignment, STEM integration, or assessment literacy)?
- Which supports, resources, or systems could help teachers address identified areas for growth?
- How will progress be monitored to determine the effectiveness of implemented actions?

Section 3: Taking Action

Putting Data to Use

Use the findings from the data analysis process to identify priorities, select evidence-based actions, and develop a plan for continuous improvement. Focus on strengthening STEM teaching and learning through targeted instructional practices, supports, and resources.

These steps help the team translate data into actionable next steps that address identified needs, build on strengths, and improve student outcomes.

Step 4—Key Findings

What are the key conclusions? What goals should be established based on identified needs?

Use the findings from the data analysis process to identify priorities and develop two to three SMART goals that address the identified needs. Goals may be developed, revised, or refined as new data becomes available.

SMART Goals

- **Specific:** Clearly define the desired outcome.
- **Measurable:** Include a quantifiable measure of success.
- **Attainable:** Establish a realistic target.
- **Relevant:** Align with identified needs and priorities.
- **Time-Bound:** Specify a timeline for achieving the goal.

SMART Goal Template
The percentage of [student group] scoring [performance level] or higher in [content area or skill] will increase from [current percentage] to [target percentage] by [date] as measured by [assessment tool] administered on [date].

Example SMART Goals:

Summative Assessment Example

> Eighty percent of biology students will demonstrate growth in designing and describing investigations and analyzing data and sources of error by improving at least one performance level from the course pre-assessment administered on August 25, 20XX, to the end-of-course assessment administered on May 23, 20XX.

Formative Assessment Example

> Eighty percent of grade 7 mathematics students will demonstrate improved attitudes toward mathematics by the end of the first semester, as measured by a student attitude survey administered on December 19, 20XX.

Performance-Based Assessment Example

> Eighty percent of grade 3 students will achieve a score of three or higher on a STEM design challenge aligned with Science TEKS 3.6.A by the end of the first six weeks, as measured by a teacher-developed STEM design challenge rubric administered on September 25, 20XX.

Step 5—Plan

What actions can the data team take to achieve the identified goals?

Use the findings from the data analysis process to identify strategies and actions within the data team's direct control or influence. Focus on evidence-based practices that address identified needs and improve student outcomes in STEM.

Examples of Guiding Questions:

- How will the instructor know whether the strategies are working?
- What evidence will demonstrate that students are making progress toward the intended learning outcomes?
- What student behaviors, products, or performance indicators should be observed because of instruction?
- What evidence will indicate that students have mastered the targeted concepts, skills, or practices?
- What are students who meet or exceed expectations able to do successfully?
- How will student work, assessment results, or classroom observations demonstrate growth over time?
- What formative, summative, or performance-based data will be collected to monitor progress?
- How will the team determine whether adjustments to instruction or interventions are needed?

Section 4: Reflection and Continuous Improvement

Step 6—Monitor

What does the new data tell the data team?

Monitor implementation and review new data to determine whether the selected strategies are producing the intended results. Use evidence to assess progress toward goals and identify any needed adjustments.

Examples of Guiding Questions:

- How are students responding to the implemented strategies?
- What does the formative data reveal about student learning and progress?
- To what extent have the identified goals been achieved?
- How much growth have students demonstrated since implementation?
- What evidence indicates that students are making progress toward the intended outcomes?
- Which students or student groups are demonstrating growth, and which may require additional support?
- What changes in student performance, engagement, or learning behaviors are evident?
- What adjustments to instruction, interventions, or supports may be needed based on the results?

Evidence of Impact:

- Compare current results with baseline data and established goals.
- Identify trends in student growth and achievement.
- Review formative, summative, and performance-based assessment data.
- Use findings to refine instructional practices and determine next steps.
- Celebrate success and identify opportunities for continued improvement.

Step 7—Evaluate

What did the data team learn, and what should be done next?
Review the results of the implemented strategies and evaluate the impact on student learning. The evaluation process marks the beginning of a new cycle of continuous improvement. The insights gained from implementation and monitoring become the foundation for the next round of data analysis, goal setting, and action planning.

Examples of Guiding Questions:

- To what extent were the identified goals achieved?
- What evidence demonstrates the impact of the implemented strategies?
- Which actions were most effective in improving student outcomes?
- What challenges or barriers emerged during implementation?
- What new strengths, needs, or opportunities for growth are evident in the data?
- What adjustments should be made to improve future implementation?
- What additional data should be collected or analyzed?
- What practices should be continued, refined, expanded, or discontinued?
- What new questions have emerged from the results?

Conclusion

Data-driven decision-making is an ongoing process of inquiry, reflection, and improvement. By continuously analyzing data, identifying needs, implementing evidence-based strategies, monitoring progress, and evaluating results, data teams can make informed decisions that strengthen STEM teaching and learning. The evaluation process informs the next cycle of improvement, creating a continuous process focused on increasing student achievement and expanding opportunities for all students.

Glossary

Engineering design process is a thinking process associated with STEM learning whereby students use an iterative process of asking questions, brainstorming, planning, creating, building, testing design ideas or solutions, and improving designs.

Formative assessment provides feedback on student learning that guides adjustments by both teachers and students during learning.

Inquiry-based learning is an approach to learning that emphasizes the student's role in the learning process. Rather than the teacher telling students what they need to know, students are encouraged to explore the material, ask questions, and share ideas. Instead of memorizing facts and material, students learn by doing.This allows them to build knowledge through exploration, experience, and discussion.

Performance-based tasks are meaningful activities or assessments that engage students in performing or demonstrating their knowledge, understanding, and proficiency.These tasks involve pertinent concepts and skills, multiple layers of complexity, multiple entry points, and multiple solutions or strategies.

Pre-assessment is a type of formative assessment that occurs before a unit of study begins. Whether formal or informal, pre-assessments are never graded; they are purely diagnostic.

Problem of practice refers to a specific, actionable issue or challenge that educators or professionals identify within their practice. It's something that can be addressed through targeted strategies and interventions. This concept is often used in educational settings to improve teaching and learning outcomes.

Professional Learning Community *refers to a collaborative team of educators who regularly examine student learning data, reflect on instructional practices, and implement evidence-based strategies to improve teaching and learning outcomes*.

Project/Product-based learning (PBL) is a learning experience that involves active participation in a project over an extended period, engaging students in solving a real-world problem or answering a complex question. Students demonstrate their knowledge and skills by developing authentic products or solutions. As a result, students develop deep content knowledge as well as critical thinking, creativity, and communication skills through an authentic, meaningful project.

STEM fluency skills refer to the skills associated with STEM teaching, learning, and the STEM workforce. In grades PK–8, the focus is on developing skills related to communication, creativity, collaboration, critical thinking, and resilience. In high school, students demonstrate mastery of PK–8 skills and develop skills in promptness, time management, adaptability, and innovation.

Summative assessment occurs at the end of the learning process. Some examples of summative assessments include tests, projects, demonstrations, presentations, and performance tasks.The purpose of summative assessment is to provide evidence of the degree to which a student has mastered the knowledge, understanding, and skills of the unit/learning experience.