STATE OF ALABAMA
DEPARTMENT OF EDUCATION

Eric G. Mackey, Ed.D.
State Superintendent of Education

October 26, 2022

M E M O R A N D U M

TO: City and County Superintendents of Education

FROM: Eric G. Mackey
State Superintendent of Education

RE: Career and Technical Education Middle Grades Innovation Grant

The Alabama State Department of Education is accepting proposals from local education agencies for funding to expand Career and Technical Education in Middle Grades. The deadline to submit the Middle Grades Innovation Grant application is November 23, 2022, at 5 p.m. Send applications with supporting documentation to Dr. Jimmy Hull, Assistant State Superintendent for Career and Technical Education/Workforce Development, Alabama State Department of Education, ATTN: Mr. Mark L. McGhee, Education Administrator, Post Office Box 302101, Montgomery, Alabama 36130-2101.

A virtual informational meeting will be held on Friday, October 28, 2022, at 10 a.m. and virtual office hours for technical assistance will be held on Friday, November 4, 2022, from 10 a.m. to 12 noon. Both meetings can be accessed by clicking this link (https://bit.ly/3VnXrc9) and using the password **CTE2022**.

If you have any questions, please contact Mr. McGhee by telephone at 334-694-4760 or by email at mark.mcghee@alsde.edu.

EGM:JH:MLM

Attachment

cc: City and County Career and Technical Education Administrators
City and County Chief School Financial Officers
Mrs. Angela Martin
Dr. Brandon T. Payne
Dr. Jimmy Hull
Mrs. Dawn Morrison
Mrs. Lynn Shows
Mr. Barry Kachelhofer
Mrs. Nancy Smith
Mr. Mark L. McGhee

FY23-2007

ALABAMA STATE DEPARTMENT OF EDUCATION
Career and Technical Education/Workforce Development

FISCAL YEAR (FY) 2023
Career and Technical Education Middle Grades Innovation Grant

Application Deadline

All applications must be received by 5 p.m. CST on

Wednesday, November 23, 2022

Virtual Informational Meeting
Friday, October 28, 2022, 10 a.m.

Virtual Office Hours for Technical Assistance
Friday, November 4, 2022, 10 a.m. to 12 noon

Link for Virtual Meetings
https://bit.ly/3VnXrc9
Password: CTE2022

Dr. Jimmy Hull, Assistant State Superintendent
Alabama State Department of Education
Career and Technical Education/Workforce Development
ATTN: Mr. Mark L. McGhee
P. O. Box 302101
Montgomery, AL 36130-2101

Table of Contents

General Information

Expanding Middle Grades CTE to Promote Lifelong Learner Success

Research has identified middle school as a time when students can benefit the most from career exploration, a process of building self-awareness, learning about potential careers, and developing a plan for reaching future goals. Career exploration engages middle school students at a time when they are at a higher risk for disengaging from learning due to challenges in forming identity, coping with puberty, and navigating new environments. It also capitalizes on their developing abilities to think abstractly, and their preferences for teamwork and active learning through relevant real-life scenarios. These preferences make middle school a natural time for students to learn about careers and develop skills such as problem solving, critical thinking, and teamwork through career exploration activities.

Career and technical education (CTE) in the middle Grades 5-8 has the power to expose students to college and career options and equip them with the transferable skills they need to plan for and succeed in high school and beyond. Middle grades CTE adds relevancy to students' learning experiences by exposing them to real-world options and connecting academics to career and college options. According to the National Drop Prevention Center, CTE in middle grades can also serve as a key dropout prevention strategy, mitigating many of the challenges students face as they transition into high school, such as disengagement or lack of preparation.

In support of the educational initiatives of the Alabama State Department of Education (ALSDE), the Middle Grades Innovative Grant is an opportunity for schools to establish, expand, start up and/or reinvent career and technical education experiences for students enrolled in Grades 5-8.

Federal Legislation and Guidance Program Purpose, Goals, and Activities

Perkins V gives states clear permission to include middle grades in their Perkins supported talent development pipelines. Congress intentionally aligned Perkins V with the *Every Student Succeeds Act* (ESSA), which defines middle grades as Grades 5-8. As a result, states can now choose to use Perkins funds to support the expansion of CTE and career exposure opportunities as early as the fifth grade. This expansion of funding eligibility to the middle grades has the potential to broaden and diversify the pipeline of prospective learning that enter secondary CTE programs.

Section 135 of Perkins V requires that states describe how they will provide career exploration and career development activities through an organized, systematic framework. This framework is meant to serve students from middle school, through high school and beyond, helping them make informed plans and decisions about future education and career opportunities and programs of study.

The systematic framework that is being recommended for this purpose is the *Design Principles for Middle Grades CTE (Appendix A),* a collaborative work from AdvanceCTE and ACTE. The framework provides the overarching purpose of middle grades CTE, which is to expose students to the 16 Career Clusters. Beyond this purpose, additional goals include the following:

- Increase self-awareness and begin to form their potential occupational identity.
- Develop employability skills.

- Develop foundational technical skills as appropriate.
- Be positioned to make more informed educational choices.
- Transition to high school with an actionable plan for next steps.

Grant applicants should carefully review the *Design Principles Self-Assessment in Appendix B* as each component should be addressed in your proposal submission.

Alabama Career Development Model (ACDM)

This K-12 framework is designed to provide all students with the necessary knowledge, skills, and abilities to be college and career ready and prepared to enter postsecondary education or the workforce. The ACDM is designed to provide local education agencies (LEAs) with the objectives and appropriate targets for the implementation of a locally developed plan. The ALSDE recommends that LEAs include educators, counselors, career coaches, and stakeholders to implement this model effectively. To assist schools in delivering required career development activities, the ACDM provides suggested targets and instructional strategies at each grade level. Through intentional, carefully planned activities and interactions, the ACDM provides advocacy, equity, and collaboration. Click this link to access the full ACDM https://bit.ly/3MFwQ6a.

Grant Proposal Guidelines

Eligibility

- Applicants must be an Alabama public school LEA submitting on behalf of schools with middle grades students (Grades 5-8).
- Applicants must complete all requirements including the cover page with assurances and signatures, the narrative, and the budget detail.

Priorities and Required Activities

Applicants for the Middle Grades STEM and CTE Career Exploration, Start-Up/Reimagining Grants will be required to demonstrate the ability to create sustainable, positive change in their district aligned to the following priorities:

1. **Alignment:** Priority will be given to applicants that can demonstrate a clear progression of course offerings between middle schools and high schools and/or technical centers for their students.
2. **Strong advisement for all students:** Priority will be given to applicants that can demonstrate a plan for projects and activities focused on career guidance and advisement through a blend of rigorous and engaging core academic and career-technical instruction. There must be an intentional connection, specifically to the *Student Mathematical Practices* and *Science and Engineering Practices (see Appendices C and D).*
3. **Alabama Career Development Model:** Priority will be given to applicants that demonstrate use of the Alabama Career Development Model in the scope of the proposed grant activities.
4. **Industry and/or postsecondary partnerships:** Priority will be given to applicants who include an industry and/or postsecondary partner in the scope of the proposed grant activities.

Competitive Priority

Each of the competitive priorities are worth an additional four (4) points for a total of 12 points.

Grant Award Amounts and Accountability Information

- **Type of Award:** Competitive
- **Estimated Amount of Available Funds:** Each Workforce Development Region can receive up to three (3) CTE Career Exploration Start-Up/Reimagining Grants in the amount of $50,000 and up to two (2) STEM focused grants in the amount of $200,000. Total amount awarded is $550,000 per Workforce Development Region. Anticipated total amount to be awarded is $3.85 million.
- **Estimated Number of Awards:** 35 awards
- **Accountability Requirements:** Awarded applicants will be required to complete the following as a required grant activity:
    - Final report and/or presentation on the achievements and expenditures made possible through the Career and Technical Education Middle Grades Innovation Grant. This will be a culminating artifact and will occur no later than October 15, 2023.
- Grantees must never supplant (replace) previously existing local, state, or federal funds. Grant funds are intended to supplement (increase) other available sources of funds.
- Note: The Department is not bound by any funding or award estimates in this notice. Additional programmatic requirements may be required to ensure compliance.

Grant Period

The grant award is made available for the period of October 1, 2022 - September 30, 2023.

Critical Dates

Friday, October 21, 2022	Applications available
Friday, October 28, 2022	Virtual informational session at 10 a.m.
Friday, November 4, 2022	Virtual office hours for technical assistance 10 to 12 noon. Link for both meetings: https://bit.ly/3VnXrc9 Password: CTE2022
Wednesday, November 23, 2022	Deadline for applications (no later than 5 p.m. CST)
Friday, December 16, 2022	Grant award letters released to applicants
Saturday, September 30, 2023	Expenditure of funds deadline

Grant Submission Instructions

Complete all three (3) parts of the grant application (cover page, narrative, and budget page) and return on or before November 23, 2022, at 5 p.m. CST. Mail or hand-deliver three (3) copies to:

Mail	Hand-Deliver
Dr. Jimmy Hull, Assistant State Superintendent for CTE/WFD ATTN: Mark L. McGhee P. O. Box 302101 Montgomery, AL 36130-2101	Dr. Jimmy Hull, Assistant State Superintendent for CTE/WFD ATTN: Mark L. McGhee Gordon Persons Building 3rd Floor, Room 3317 50 North Ripley Street Montgomery, AL 36104

No emailed or faxed copies will be accepted.

Career and Technical Education Middle Grades Innovation Grant
FY 2023 Grant Application

Part 1 - Application Cover Page

LEA: _____ **System Code:** _____

Career and Technical Education Director			
Name:		**Telephone:**	
Email:		**Fax:**	
Address:			

Amount of Funds Requested:	$
Type of Grant:	☐ CTE Career Exploration/Start-Up/Reimagining Grant
	☐ STEM Focused Grant

Assurances & Signatures	
The attached application and budget are based on the grant application. I understand that only the CTE Middle Grades Innovation expenditures approved in the grant application will be reimbursed to the LEA.	I have reviewed the attached application and budget. The proposed expenditures appear to be coded properly and will be incorporated into the LEA systemwide budget.
CTE Director's Signature/Date	Chief School Financial Officer's Signature/Date

I certify that I am authorized by the governing board of the above-named school system or other eligible entity to submit this application or amendment; that all assurances, certifications, and disclosures submitted with the application will be observed; that the program will be implemented as described; and that the governing board is responsible for complying with all state and federal requirements, including any audit exceptions.
Local Superintendent's Signature Date

FOR ALSDE USE ONLY **Approved:**
Eric G. Mackey State Superintendent of Education Date

Career and Technical Education Middle Grades Innovation Grant
FY 2023 Grant Application

Part 2 – Narrative
(80 Points)

By addressing each statement below, applicants must detail a plan to create, expand, startup, or reimagine Career and Technical Education in Middle Grades. The narrative should be no more than two (2) typed pages or 1000 words.

1. Describe how the program expansion will create equity and access (20 points)
2. Describe how the success of the program will be measured (20 points)
3. Address the following design principles: (20 points)
   a. Be equitable and inclusive of each student.
   b. Be anchored in careers.
   c. Be standards based.
   d. Be grounded in experiential and hands-on learning.
   e. Balance breadth and depth across the curriculum.
   f. Be integrated into the broader K-12 or P-20 career development system.
   g. Include intentional and meaningful employer engagement.
   h. Involve dedicated instructional time.
   i. Be communicated effectively to students and their families.
   j. Be focused on student growth.
4. Provide a sustainability plan beyond the grant funds (20 points)

Note the competitive priorities worth additional points on page 4.

Part 3 - Budget Detail
(20 Points)

Applicants must include a narrative that justifies each budget item and how it will help achieve the goals outlined in the grant proposal. The budget narrative should be no more than one (1) page or 500 words. (10 points)

Using the format below, create a preliminary budget detailing how funds will be used. Based on the grant type, awards will range from $50,000-$200,000. (10 points)

Revenue/Fund Source Code: 1281

Function Code	Program Code	Object Code	Item Description	Unit Cost	Quantity	Total Cost
	3800					$
	3800					$
	3800					$
					Total	**$**

Career and Technical Education Middle Grades Innovation Grant

Scoring Rubric

LEA: _____ **System Code:** _____

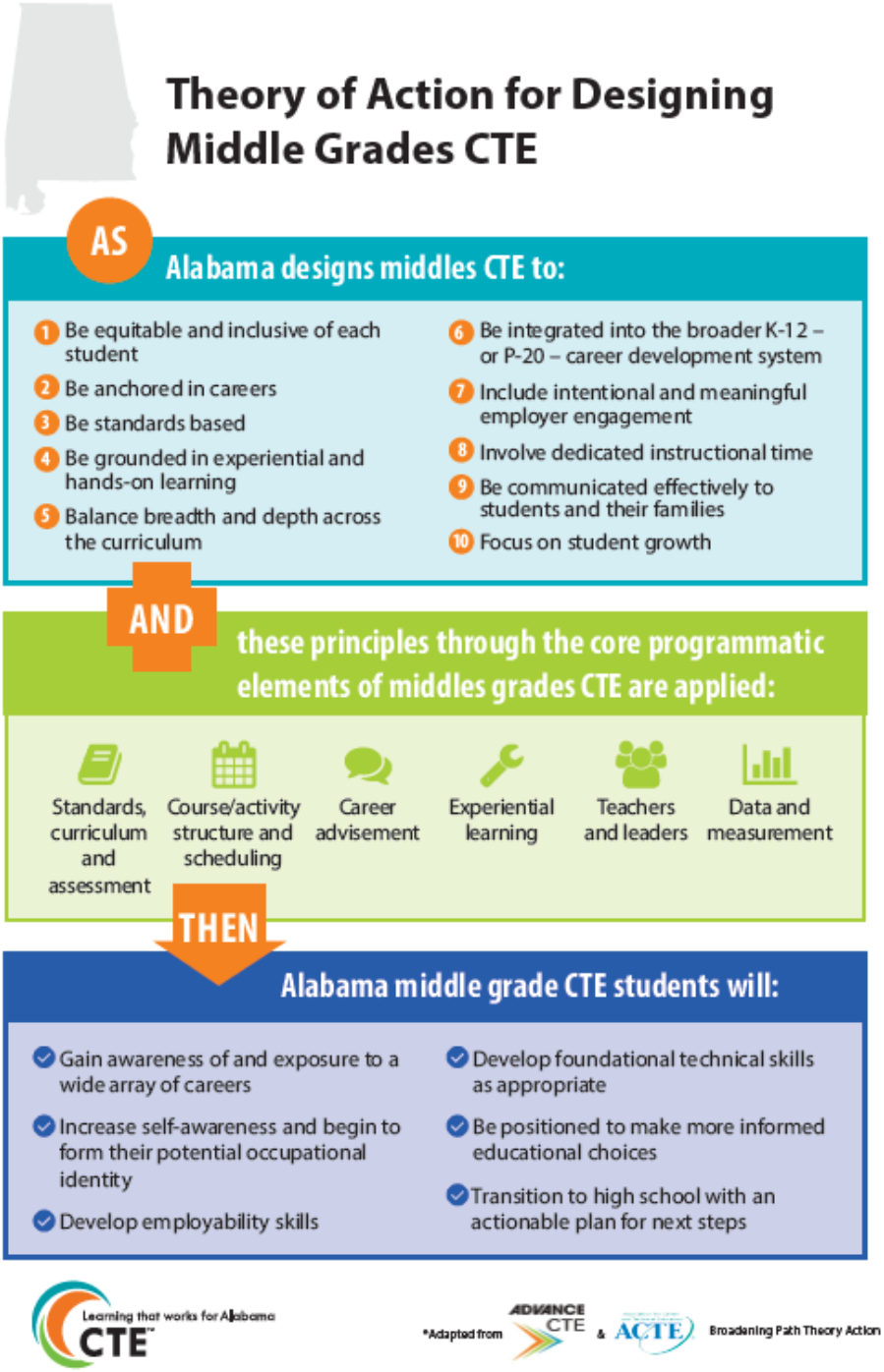
Grant Application Submitted by 5 p.m. CST on November 23, 2022.	☐ Yes	☐ No
Cover page completed including all signatures.	☐ Yes	☐ No

Narrative (80 Points)				
No more than two (2) pages/1000 words			☐ Yes	☐ No
Criteria	**(5 pts.)**	**(10 pts.)**	**(15 pts.)**	**(20 pts.)**
Describe how the program expansion will create equity and access	Statement is unconvincing or no evidence the statement was addressed.	Statement is a random collection of information and unclear.	Statement is well-developed and detailed information presented.	Statement is well-developed and fully addressed. Detailed information and clear evidence are presented.
Describe how the success of the program will be measured	Statement is unconvincing or no evidence the statement was addressed.	Statement is a random collection of information and unclear.	Statement is well-developed and detailed information presented.	Statement is well-developed and fully addressed. Detailed information and clear evidence are presented.
Address the design principles	1 design principles addressed	2-5 design principles addressed	6-9 design principles addressed	10 design principles addressed
Provide a sustainability plan beyond the grant funds	No meaningful plans for future beyond funding term appear in proposal.	Plans for future are stated as assumptions without supporting arguments or evidence.	Some effort to secure commitment beyond grant period is represented.	Evidence presented that proposal can be sustained locally, beyond grant funding.
COLUMN TOTAL				
			TOTAL	**80**

Budget Detail (20 Points)			
Criteria	**(5 pts.)**	**(10 pts.)**	
Budget Spreadsheet	Budget spreadsheet in incorrect format	Budget spreadsheet in correct format	
Budget Narrative	Narrative is a random collection of information and does not explain how funds will achieve the goals of the grant.	Narrative is well-developed addressing each budget item and explaining how funds will achieve the goals of the grant.	
COLUMN TOTAL			
		TOTAL	**20**

POINTS TOTAL	**100**
COMPETITIVE PRIORITY POINTS	**12**
TOTAL POINTS	**112**

APPENDIX A {Design Principles for Designing Middle Grades CTE}:



Appendix B {Design Principles Self-Assessment}:

To view the entire Design Principles Self-Assessment guide, click this link (https://bit.ly/3S3oAOC) and view pages 14-24.

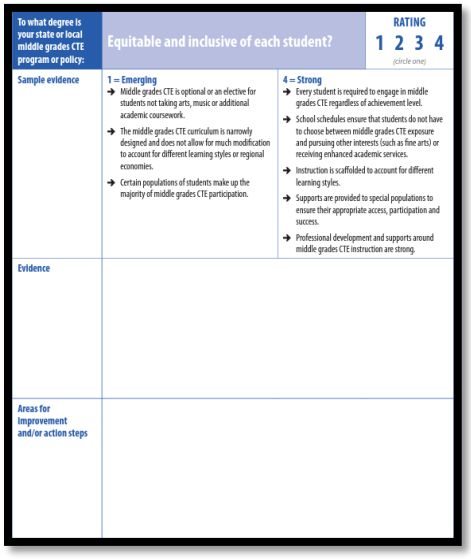
INSTRUCTIONS: This self-assessment breaks down each design principle so that state and local leaders can fully analyze their policies and programs. To use this rubric, examine each design principle; assign it a rating of 1, 2, 3 or 4 based on how your current policy or program compares to the examples in the chart; and provide written evidence for that rating. Below is a general description of each rating, and more principle-specific descriptions are provided under "1 = Emerging" and "4 = Strong" in the charts in this document.

RATINGS DEFINITIONS:

1 (EMERGING)	This design principle is not yet represented in your current or proposed middle grades CTE policy or program.
2 (BUILDING)	This design principle is somewhat represented in your current or proposed middle grades CTE policy or program, but many improvements still need to be made.
3 (PROMISING)	This design principle is fairly well represented in your current or proposed middle grades CTE policy or program, although some improvements still need to be made. The program or policy is considered to be more developed than one that is rated a 2.
4 (STRONG)	This design principle is fully represented in your current or proposed middle grades CTE policy and program with clear evidence of its impact, even if minor adjustments still need to be made.

Importantly, the sample evidence provided in the self-assessment is simply that — samples. The samples are by no means exhaustive but are meant to serve as *illustrative* examples of how a less-developed or well-developed middle grades CTE policy or program would play out at the school or student level. In some cases, a program may need to meet all of the criteria to be considered "strong"; in others, the criteria are not cumulative but identify different ways that a program can demonstrate its effectiveness for learners.

To what degree is your state or local middle grades CTE program or policy:	Equitable and inclusive of each student?	RATING 1 2 3 4 (circle one)
Sample evidence	**1 = Emerging** → Middle grades CTE is optional or an elective for students not taking arts, music or additional academic coursework. → The middle grades CTE curriculum is narrowly designed and does not allow for much modification to account for different learning styles or regional economies. → Certain populations of students make up the majority of middle grades CTE participation.	**4 = Strong** → Every student is required to engage in middle grades CTE regardless of achievement level. → School schedules ensure that students do not have to choose between middle grades CTE exposure and pursuing other interests (such as fine arts) or receiving enhanced academic services. → Instruction is scaffolded to account for different learning styles. → Supports are provided to special populations to ensure their appropriate access, participation and success. → Professional development and supports around middle grades CTE instruction are strong.



APPENDIX C {Student Mathematical Practices}:

The Standards for Mathematical Practice, called "Student Mathematical Practices" in this document, describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices are based on important processes and proficiencies that have long-standing importance in mathematics education. The processes are the National Council of Teachers of Mathematics (NCTM) process standards of problem-solving, reasoning and proof, communication, representation, and connections. The proficiencies are adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations, and relations), procedural fluency (skill in carrying outprocedures flexibly, accurately, efficiently, and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile—coupled with a belief in diligence and one's own efficacy). These are the strands of mathematical proficiency specified in the National Research Council's report, *Adding It Up*: *Helping Children Learn Mathematics* (2001). Most recently, these Student Mathematical Practices have been supported by the National Assessment of Educational Progress (NAEP) in the draft of the *2025 NAEP Mathematics Framework,* which was open for public comment in the spring of 2019. The completed *Mathematics Framework for the 2025 National Assessment of EducationalProgress,* which was released November 21, 2019, summarized the student mathematical practices into five NAEP Mathematical Practices and reaffirmed the importance of incorporating these approaches and behaviors in the study of mathematics at all levels.

The eight (8) Student Mathematical Practices are listed below along with a description of behaviors and performances of mathematically proficientstudents.

Mathematically proficient students:

1. **Make sense of problems and persevere in solving them.**
   These students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. These students consider analogous problems and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculators to obtain the information they need. Mathematically proficient students can explain correspondences among equations, verbal descriptions, tables, and graphs, or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solve complex problems andidentify correspondences between different approaches.

2. **Reason abstractly and quantitatively.**
   Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships. One is the ability to **decontextualize**, to abstract a given situation, represent it symbolically, and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents. The second is the ability to **contextualize**, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

3. **Construct viable arguments and critique the reasoning of others.**
   These students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases and can recognize and use counterexamples. These students justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments; distinguish correct logic or reasoning from that which is flawed; and, if there is a flaw in an argument, explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until the middle or upper grades. Later, students learn to determine domains to which an argument applies. Students in all grades can listen to or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

4. **Model with mathematics.**
   These students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, students might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, students might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts, and formulas and can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the contextof the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5. **Use appropriate tools strategically.**
   Mathematically proficient students consider available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and the tools' limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a Web site, and use these to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

6. **Attend to precision.**
   These students try to communicate mathematical ideas and concepts precisely. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. Mathematically proficient students are careful about specifying units of measure and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, and express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

7. **Look for and make use of structure.**
   Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. These students also can pause and reflect for an overview or a shift in perspective. They can observe the complexities of mathematics, such as seeing some algebraic expressions as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that mental picture to realize that the value of the expression cannot be more than 5 for any real numbers x and y.

8. Look for and express regularity in repeated reasoning.

Mathematically proficient students notice if calculations are repeated and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y – 2)/(x – 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x – 1)(x + 1)$, $(x – 1)(x^2 + x + 1)$, and $(x – 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As students work to solve a problem, mathematically proficient students maintain oversight of the process while attending to the details and continually evaluate the reasonableness of their intermediate results.

APPENDIX D {Science and Engineering Practices}:

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.