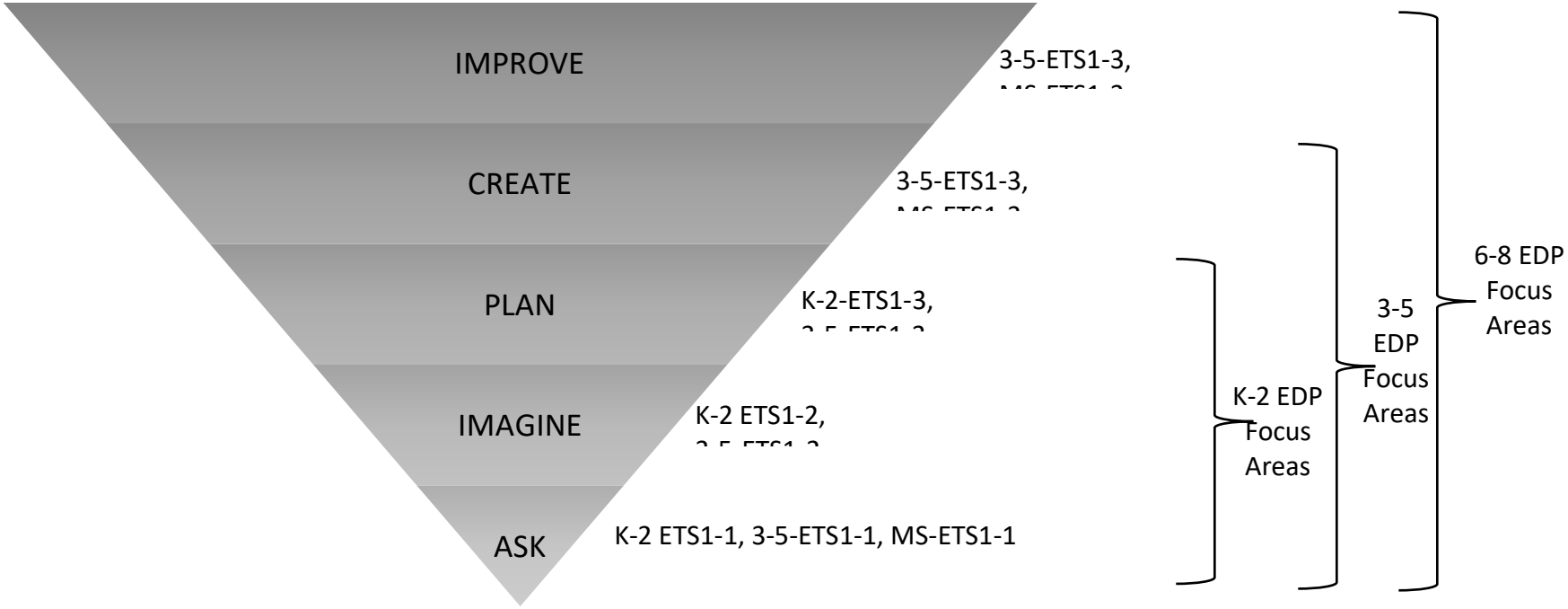
EDP Framework Learning Progression Across K-8 Grade Levels



Learning Progressions of the Engineering Design Process (EDP) Aligned with NGSS

STEM curricula included in childhood (preK-6) education has been shown to play an important role in sparking a lifelong passion for those subjects and in opening up the doors to future career paths. Maltese and Tai (2010) found that 65% of scientists and graduate students in STEM areas of study reported that an interest in science began before middle school. To better prepare students with 21st century skills and shifts in mindsets purported by NGSS to prepare young learners as young as in preschool for the growing demand for STEM jobs, curricula need to reflect these changes.

The whitepaper by the Museum of Science (2019) entitled "Engineering Learning Trajectories: What They Are and Why They Matter" offers a guiding framework across the pre-kindergarten through eighth grade continuum that identifies the developmental progression for the field of engineering that is scaffolded and age-appropriate.

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In terms of engineering knowledge (content), skills, and practices, eight areas were identified as important to consider when planning for developmentally appropriate experiences for children across the preschool through middle school continuum. They are: (a) setting the proper context for learning, (b) identifying goals, constraints, and requirements of design challenges, (c) following the steps of the engineering design process, (d) exploring materials and methods, (e) applying science knowledge (disciplinary core ideas (DCIs) and crosscutting concepts (CCCs) of the NGSS), (f) analyzing data for design and planning, (g) collaborating with peers, and (h) fostering student agency.

This table below is adapted from what the Boston Museum of Science has reported on in their 2019 whitepaper with learning trajectories for the five steps of the EDP organized by grade level clusters: K-2, 3-5, and 6-8. Consider how the learning progressions coincide with the engineering design standards in the NGSS and how the knowledge, skills, and practices build upon one another as students experience engineering education.

Learning Level	NGSS Engineering Design Standards	Learning Trajectories	What does this look like?
Lower Elementary	**ASK**	- Setting the proper context for learning - Fostering student agency	K-2: K – Read-alouds with demonstrations and whole class discussions; 2nd – Background building and (science and engineering content?) vocabulary exposure; integrated topics/subjects/contents in reading with the engineering component
Upper Elementary			3-5: Students are more independent and self-directed; they come up with the questions; they apply background knowledge and make inferences to influence the Imagine step; the learning becomes more student-centered (teacher as facilitator/guide)
Middle			6-8: Increasing complexity with topics, challenges, problems; problems relate to society (real-world); the students can focus more on the constraints when they do the research (societal, financial, material) with respect to the problem/challenge
Lower Elementary	**IMAGINE**	- Identifying goals, constraints, and requirements of design challenges	K-2: K – sketches are shapes; 2nd – Reading and examples to draw from are given; the prototypes are real-life examples

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Upper Elementary		- Exploring materials and methods - Collaborating with peers	3-5: Students are able to work in groups; teachers model how to work in a group; teacher reinforces that when someone has an idea everyone should respect that (brainstorming is encouraged)
Middle			6-8: Students use online resources to do their own research; teacher guides students with the research to select the appropriate (or offer specific) sites; drawings are labeled with supplies listed; students give multiple views (perspectives) of their designs
Lower Elementary	**PLAN**	- Following the steps of the EDP - Identifying goals, constraints, and requirements of design challenges -Collaborating with peers	K-2: K – Students begin to work in pairs; small groups are introduced (three to four in a group at most by 2nd grade); 2nd – Students can talk about the kinds of materials to use; teacher lets students explore materials first; teachers model/teach group work and cooperation/collaboration (processes, roles, norms)
Upper Elementary			3-5: Teacher/client gives multiple criteria (specs) to meet for the challenge; students given the opportunity to explore the materials first
Middle			6-8: Students go through the Pugh Chart and the decision matrix process and explain why they made those decisions; students use science and engineering vocabulary; the teacher utilizes a Gantt chart to map out the entire EDP activity for students
Lower Elementary	**CREATE**	- Applying science knowledge (DCIs and CCCs of the NGSS) - Identifying goals, constraints, and requirements of design challenges	K-2: Teacher supervises the use of materials; safety considerations for the teacher (teacher may need to prep ahead of time)
Upper Elementary			3-5: Teacher makes the steps of the EDP clear and scaffolded; students are given reflection time to analyze the data and evaluate their designs; quantitative data

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		- Analyzing data for design and planning - Collaborating with peers	collection; increasing connections of science ideas/concepts with the engineering problem; students are able to make personal connections to the challenges
Middle			6-8: The steps of the EDP are made clear (use of notebook) and the teacher doesn't move ahead until everyone is ready; encouraging the iterative process of "If it didn't work then go back and do more research"; able to use the data and conduct further investigations as needed (application of results); science concepts are connected with the results/data
Lower Elementary	**IMPROVE**	- Analyzing data for design and planning - Collaborating with peers - Fostering student agency	K-2: K – More verbal process of improvement with hands-on experiences with less writing and simplified notebook Gr 1/2 – Given an appropriate challenge, students will be engaged; students will figure out reasons/causes for the problem and why they need to improve upon existing designs/solutions; students need prompting if they don't recognize what is faulty with the design
Upper Elementary			3-5: Able to write things down as well as verbalize understandings and processes; students are able to use a notebook and want to "jump in" to improve their designs; students need to be reminded to show their plans and be able to justify them (in their notebook)
Middle			6-8: Similar to grades 3-5, but students can also present to the class and share designs and learn from one another; seeing other perspectives; vocabulary (science and engineering content?) use throughout all steps (using this in conversation); teacher needs to direct students back to the specs to encourage them to reflect, iterate, and improve their designs

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Lower Elementary	**COMMUNICATE**	- Asking and answering questions - Collaborating with peers - Fostering student agency - Communicating Information	K-2:
Upper Elementary			3-5:
Middle			6-8:

*These are the results from Session #2 on 10/26/19. The "Communicate" step is added in for each of you to consider what this might look like for your grade levels and/or grade level clusters. Consider this as you plan for the final showcasing at your school by the end of the school year in May 2020. Our PAF and STEM Pre-Academy teams look forward to this student sharing and showcasing events.