EIE's Engineering Learning Trajectories

Critical Component or Design Parameter	What it looks like:				
	Ages 3–4	Ages 5–6	Ages 7–8	Ages 9–10	Ages 11–12
Narrative Context	- The teacher presents the context through dialogue and role play, e.g., with a puppet. - The teacher scaffolds children's dialogue. - The topic is within children's experience, but still requires discussion and support. - The teacher reads supplementary stories, provides pictures and exemplars, and supervises other supplementary experiences to expand children's knowledge base.	• The context can be presented through characters in a short picture book. • The teacher reads aloud and supports comprehension through questioning. • The topic involves a child's personal problem, familiar to children of this age. • The teacher reads supplementary stories, provides pictures and exemplars, and supervises other supplementary experiences to expand children's knowledge base.	• The context can be presented through characters in a longer picture book. • The teacher reads aloud and supports comprehension through questioning. • The topic is familiar to children indirectly through texts and media. • The teacher reads fiction and non-fiction books, provides video clips and exemplars, and supervises other supplementary experiences to expand children's knowledge base.	• The context can be presented through illustrated short chapter books. • Children can read independently with significant comprehension support. • The topic can involve personal, social, industrial, or environmental problems. • In addition to supplementary resources and experiences used in earlier grades, children can now read and investigate independently in books and online.	• The context can be presented through longer texts, documentaries, and media reports; non-fiction is preferred. • Children can read independently with less support. • The topic can involve more current or complex societal or environmental problems. • In addition to supplementary resources and experiences used in earlier grades, children can now read and investigate independently in books and online.
Goals, Constraints, and Requirements	• The technology is something children have used before. • Children design a technology that is functional and affords imaginative play. • No more than two criteria for success are specified. • A small variety of available materials affords a variety of valid solutions while not overwhelming children.	• The technology is something children have seen or heard about. • Children design a technology or model with a function that can be understood with some hands-on experimentation. • Up to three criteria for success are specified. • A variety of available materials and methods afford a variety of valid solutions.	• The technology may be new to children. • Children design a technology or model with one or two functions that are readily understood with instruction. • Up to four criteria for success require trade-offs. • Balanced trade-offs ensure that many valid solutions are possible.	• The technology may be new to children. • Children design a technology or model that may have multiple functions or be part of a system; functions may require some instruction to understand. • Up to five constraints and requirements may involve calculations and measurement in scoring. • Balanced trade-offs ensure that many valid solutions are possible.	• The technology may be new to children. • children design a technology or model that may be made up of multiple subsystems; functions may require instruction and investigation to understand. • Up to six constraints and requirements may involve calculations and measurement in scoring. • Balanced trade-offs ensure that many valid solutions are possible.

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EIE's Engineering Learning Trajectories, cont.

Critical Component or Design Parameter	What it looks like:				
	Ages 3–4	Ages 5–6	Ages 7–8	Ages 9–10	Ages 11–12
Engineering Design Processes (EDP) and Practices	• The EDP has 3 steps. • Children engage in problem scoping, creating and testing prototypes, and making improvements. • Teachers work directly with children to provide verbal scaffolding and model epistemic practices. • Materials provide visual scaffolding without the need for reading. • Children communicate what they've done with drawings, photos, and speech.	• The EDP has 3 or 4 steps. • Children engage in problem scoping, creating and testing prototypes, making improvements, and communicating designs. • Teachers provide verbal scaffolding and model epistemic practices for the class. • Materials are mostly visual but begin to incorporate symbols. • Children communicate their ideas and their designs with drawings, photos, speech, and labels."	• The EDP has 4 or 5 steps. • Children engage in problem scoping, brainstorming, drawing up plans, creating and testing prototypes, evaluating to make improvements, and communicating designs. • Teachers model for the class and ask open-ended, generative questions to encourage children to actively engage. • Materials scaffold all processes through simple prompts. • Children communicate ideas, designs, and conclusions with drawings, basic writing, and class discussion.	• The EDP has 5 or 6 steps. • Children engage in practices from earlier grades with more independence. • Teachers model for the class and ask open-ended, generative questions to encourage children to actively engage, reflect, and draw conclusions. • Materials scaffold all processes through extended prompts and some instruction. • Children communicate ideas, designs, conclusions, and synthesis with drawings, extended writing, class discussion, and brief team presentations.	• The EDP has 7 or 8 steps. • Children engage in practices from earlier grades with more independence. • Teachers begin and end each activity with open-ended, generative questions to encourage children to reflect and draw conclusions. • Materials provide higher-level scaffolding of all processes, with extended instruction and some prompts. • Children communicate ideas, designs, conclusions, synthesis, and arguments with drawings, extended writing, class discussion, and extended team and class presentations.
Materials and Methods	• Children explore a single physical property of all materials and group or arrange them according to that property with significant teacher support. • Children explore a basic method or tool (e.g., taping, cutting, fastening with elastics).	• Children explore two properties of the materials that are important to the design and compare materials for suitability with significant teacher support. • Children make use of a variety of basic tools and methods for construction.	• Children explore, describe, compare, and evaluate the properties of materials for use in a design solution with teacher support. • Children make use of a variety of methods and basic tools for construction, including specialized methods (e.g., folding paper to create a beam).	• Children explore, describe, compare, evaluate, and make arguments about the properties of materials for use in a design solution with teacher or written support. • Children make use of a variety of methods and tools for construction, including specialized methods and tools (e.g., a goniometer or temperature gauge).	• Children explore, describe, compare, evaluate, and make arguments about the properties of materials for use in a design solution with support from written prompts. • Children make use of a variety of methods and tools for construction, including specialized methods and tools requiring maturity and/or adult supervision (e.g., a sharp blade).

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EIE's Engineering Learning Trajectories, cont.

Critical Component or Design Parameter	What it looks like: Ages 3–4	Ages 5–6	Ages 7–8	Ages 9–10	Ages 11–12
Application of Science and Mathematics	• The design challenge connects with basic life, Earth, or physical science principles. • Children practice counting and using qualitative measures.	• The design challenge connects with learning objectives from age-appropriate science content. • Children use non-standard measures, use simple arithmetic, and collect simple data with structured support.	• The most successful design solutions will take scientific considerations into account from age-appropriate science content. • Children use standard measures, calculate scores, and collect and record data.	• A successful design solution will take scientific considerations into account from age-appropriate science content. • Children take measurements, calculate variables and scores, collect and record data, and construct charts and tables at an age-appropriate level.	• A successful design solution will take scientific considerations into account from age-appropriate science content. •Children take measurements, calculate variables and scores, collect & record data, and construct charts & tables at an age-appropriate level.
Analysis of Data for Planning and Redesign	• Children test materials and evaluate them on a two-dimensional scale (e.g., louder/quieter). • With teacher support, children construct simple charts or compare results through whole-group discussion. • Children judge the success of their design solution through observation and comparison against a standard, low-quality solution. • Children are encouraged to improve their designs repeatedly.	• Children test materials and evaluate them for specific qualities. • With teacher support, children construct graphs and charts and discuss and compare results across the class to draw lessons for planning a design solution. • Children judge the success of a design solution using a specified testing procedure to make qualitative judgments. • Children are encouraged to use their results and findings to improve their designs repeatedly.	• Children test materials and methods of construction for specific qualities. • With teacher support, children construct graphs and charts and discuss and compare results across the class to draw lessons about "fair tests" and planning a design solution. • Children judge the success of a design solution using a specified testing procedure to make qualitative judgments and quantitative measures. • Children analyze and describe which parts of their technology failed during testing and offer suggestions for modifications they will make in redesign.	• Children analyze data collected from specified controlled experimentation with materials and methods to inform design planning. • With teacher and written support, children construct graphs and charts and discuss and compare results across the class to draw lessons about reliability, variability, and planning a design solution. • Children judge the success of a design solution using a specified controlled testing procedure using quantitative measures and qualitative rubrics. • Children analyze data from testing of design solutions to understand points of failure and improve upon them in redesign.	• With teacher support, children decide how to conduct tests of materials and methods and evaluate results, which may vary across groups or repetitions. • With written support, children construct graphs and charts, discuss and compare results, and draw conclusions for planning a design solution; with teacher support, they discuss reliability and variability as a class. • Children judge the success of a design solution by using a specified controlled testing procedure and/or by devising their own testing procedures using quantitative measures and qualitative rubrics. • Children analyze data from testing of design solutions to understand points of failure and improve upon them in redesign.

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EIE's Engineering Learning Trajectories, cont.

Critical Component or Design Parameter	What it looks like: Ages 3–4	Ages 5–6	Ages 7–8	Ages 9–10	Ages 11–12
Collaboration	• Children work alone or in freely formed groups. • The teacher leads children to interact during whole-group or small-group discussion. • The teacher praises successful interactions and supports children to manage contentious interactions.	• Children work in pairs, sharing materials but designing their own solutions. • The teacher discusses and models appropriate interactions. • The teacher praises successful interactions and supports children to manage contentious interactions.	• Children collaborate in pairs or groups of 3 on a shared design solution. • The teacher discusses and models appropriate interactions. • The teacher provides support to consider each other's ideas and negotiate shared solutions."	• Children collaborate in groups of 3-4 on a shared design solution. • The teacher discusses and models appropriate interactions. • The teacher and written materials provide support and prompts so children consider each other's ideas and negotiate shared solutions.	• Children collaborate in groups of 3-5 on a shared design solution. • The teacher discusses appropriate interactions, and offers suggestions for how children can manage their groupwork. • Written materials convey the expectation that the group will come to a consensus on how to conduct group work and what to do.
Agency	• The teacher may directly support the process with prompts and structure. • Children make their own choices and engage directly with the materials. • Simple visual materials support children to focus on important aspects of materials and the problem.	• The teacher models for children and prompts them to come up with and try new ideas. • Children make their own choices and engage directly with the materials. • Simply written or visual materials support children to focus on important aspects of the problem.	• The teacher models for children and prompts them to come up with their own questions and ideas, as well as to make observations and draw their own conclusions. • Children work together to make decisions and plans as a team, and to create, test, and improve their ideas. • Written materials support children to reflect and make connections through open-ended prompts for short answers and basic observations.	• The teacher models for children and prompts them to come up with their own questions, ideas, and hypotheses, as well as to make observations, decide how to test materials, and draw their own conclusions. • Children work together to make decisions and plans, and to create, test, evaluate, and improve their ideas. • Written materials support children to reflect and make connections through open-ended prompts for extended reasoning and detailed observations.	• The teacher encourages children to come up with their own questions, ideas, and hypotheses, as well as to make observations, decide how to test materials, design experiments and tests, and draw their own conclusions. • Children work together to make decisions and plans; to decide how to test materials and methods and how to evaluate their solutions; and to create, test, evaluate, and improve their ideas. • Written materials support children to reflect and make connections through open-ended prompts for extended reasoning and detailed observations.

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