FRAMEWORK CONSTRUCTS

CONCEPT		LOW STRUCTURE	HIGH STRUCTURE
STEM-embedded play design at exhibits	How is the exhibit designed so that the play activity provides the context for a child to experience or observe a STEM phenomenon? **This concept helps to answer questions like:** What is it? What does it do? **Examples:** A toy boat floating (low) or navigating a maze that represents the water cycle (high)	• **Object** play that is free of external rules and based on manipulation of materials • Children are guided to explore the existence and/or physical properties of STEM phenomena through the manipulation of materials • Objects become tools that allow for divergent sense-making experiences of STEM phenomena	• **Game** or ludic play with rules • Children are guided to employ strategy, logic, and reasoning as they observe STEM phenomenon • Games allow for convergent sense-making of STEM phenomenon through challenge or mastery
Facilitators of play-based STEM	How is the exhibit designed to support a combination of play activities, social play forms, and adult interactions that facilitate the engagement of STEM practices? **This concept helps to answer questions like:** What happens when…? **Examples:** Child watches another child reposition the weights on a toy boat (low) or an adult explains how rain becomes groundwater (high)	• A combination of kinesthetic, sensorial, or imaginative play activities provides opportunities for children to discover properties, rules, or nuances related to a STEM phenomenon • Social (joint) and non-social (onlooker, parallel) play experiences can facilitate opportunities for children to discover properties, rules, or nuances related to a STEM phenomenon • Adults offer guidance through support or modeling	• A combination of object, kinesthetic, sensorial, or imaginative play activities facilitates developing a hypothesis, motivation to master, and negotiating as children draw a conclusion • Social (joint) and non-social (onlooker, parallel) play experiences can facilitate developing a hypothesis, motivation to master, and negotiating as children draw a conclusion • Adults offer guidance through inquiry, directing, or explaining

CONCEPT		EARLY STEM PRACTICES
STEM Practices	How is the exhibit designed to support the use of STEM practices? **This concept helps to answer questions like:** What can I do? and How can I explore this STEM phenomenon? **Examples:** Child revises by removing the small weights and replacing them with heavier weights that then sink the toy boat or the child tries to move the table maze so that the ball moves to the rain space before completing the maze	**Children are engaging in play-based exploration and sense-making where they are:** • Using observations • Testing • Revising • Designing • Using evidence • Communicating STEM • Asks questions • Make predictions

Notes:
Exhibits with STEM phenomenon are characterized by complex, contextualized investigations where the learning process is guided by practices. The context of the phenomena can be a real-world STEM object such as a tree, robot, or rainbow, or a STEM concept like heat, cold, or ecosystem. STEM phenomena events can be observed or experienced directly or in mediated ways. This designed for experience or observation of a STEM phenomenon within a play activity provides the foundation for inquiry. STEM Phenomenon are not isolated topics, where learning occurs through passive or direct instruction. Game-based play and object-based play are structured to provide opportunities that are flexible where children can manipulate the interactive elements of the exhibit. This differs from the other play activities. For example, a child engaged in kinesthetic play such as jumping up and down is not manipulating interactive elements or design of the exhibit, but if the exhibit was focused on the phenomenon of mass, jumping up and down on a scale may facilitate engagement with STEM practices. Additionally, the structure of game and object-based play allow for direct observation of a child making an observation or experiencing a STEM phenomenon. Low and high structure refers to the spectrum of play-based learning (Zosh et al., 2018) and the degree to which adult guidance or goal orientation influences the child's play activity. For example, free play is completely unstructured with no adult-directed guidance, or orientation towards a particular learning goal, whereas on the opposite end of the spectrum, the use of games for learning is highly structured, designed to be driven by rules, and designed with a learning goal in mind. Classifying the nuance of structure within the guided play design of an exhibit allows for reflection on the initiation of the child to engage with a STEM phenomenon through play, the degree of facilitation to further engage with a STEM phenomenon, and how the structure can be a pedagogical tool to guide the use of STEM practices at play-based STEM at exhibits.