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## Constructivism and the Five E's

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**Constructivism.** The philosophy about learning, that proposes learners need to build their own understanding of new ideas, has been labeled constructivism. Much has been researched and written by many eminent leaders in the fields of learning theory and cognition. Scholars such as Jean Piaget, Eleanor Duckworth, George Hein, and Howard Gardener have explored these ideas in-depth. The Biological Science Curriculum Study (BSCS), a team whose Principal Investigator is Roger Bybee developed an instructional model for constructivism, called the "Five Es".

Briefly, this learning approach as it relates to science can be summarized as follows: Learning something new, or attempting to understand something familiar in greater depth, is not a linear process. In trying to make sense of things we use both our prior experience and the first-hand knowledge gained from new explorations. Initially, our curiosity about a science topic is stirred, as we are stimulated by some intriguing phenomena, such as a rainbow, we've noticed. We poke, probe, inquire about and explore this phenomena until it becomes less mysterious. As we begin to investigate new ideas we can put together bits and pieces of prior explorations that seem to fit our understanding of the phenomena under present investigation. In the case of the rainbow, for example, we may realize that there is an association between sunlight and water vapor. Piece by piece we build knowledge. Sometimes when the pieces don't fit together, we must break down old ideas and reconstruct them. (Following a rainbow to find a pot of gold doesn't work easily!) We extend our conceptual understanding through discussions and creative efforts. We validate our theories as we solve problems. In our rainbow example, we may realize that if we position ourselves properly, we can create a rainbow by spraying a water hose in sunlight. The clarity we've gained in understanding a concept gives us the ability to apply this understanding to new situations and new mysteries. It is a continuous and a very individual process. We bring to each learning experience our developmental level, our personal story and our personal style.

It is up to the teacher to facilitate the constructivistic learning process. The structure of the learning environment should promote opportunities and events that encourage and support the building of understanding.

We have used an adaptation of BSCS's model to introduce the pH factor. Our instructional model is called the "Seven Es". Investigations and activities are included under the headings of each E. They are presented to be taught either in sequence or independently, at the teacher's discretion. Each investigation is designed to stand on its own and be introduced when deemed appropriate.

A convenient format to view constructivism has been defined by Biological Science Curriculum Study (BSCS). In this models the process is explained by employing five "E"'s. They are: Engage, Explore, Explain, Elaborate and Evaluate.

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**Engage.** In the stage Engage, the students first encounter and identify the instructional task. Here they make connections between past and present learning experiences, lay the organizational

ground work for the activities ahead and stimulate their involvement in the anticipation of these activities. Asking a question, defining a problem, showing a surprising event and acting out a problematic situation are all ways to engage the students and focus them on the instructional tasks. If we were to make an analogy to the world of marketing a product, at first we need to grab the customer's attention. We won't have their attention unless they have a need to buy the product. They may be unaware of a need, and in this case we are motivated to create a need.

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**Explore.** In the Exploration stage the students have the opportunity to get directly involved with phenomena and materials. Involving themselves in these activities they develop a grounding of experience with the phenomenon. As they work together in teams, students build a base of common experience which assists them in the process of sharing and communicating. The teacher acts as a facilitator, providing materials and guiding the students' focus. The students' inquiry process drives the instruction during an exploration.

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**Explain.** The third stage, Explain, is the point at which the learner begins to put the abstract experience through which she/he has gone /into a communicable form. Language provides motivation for sequencing events into a logical format. Communication occurs between peers, the facilitator, or within the learner himself. Working in groups, learners support each other's understanding as they articulate their observations, ideas, questions and hypotheses. Language provides a tool of communicable labels. These labels, applied to elements of abstract exploration, give the learner a means of sharing these explorations. Explanations from the facilitator can provide names that correspond to historical and standard language, for student findings and events. For example a child, through her exploration, may state they have noticed that a magnet has a tendency to "stick" to a certain metallic object. The facilitator, in her discussion with the child, might at this stage introduce terminology referring to "an attracting force". Introducing labels, after the child has had a direct experience, is far more meaningful than before that experience. The experiential base she has built offers the student an attachment place for the label. Common language enhances the sharing and communication between facilitator and students. The facilitator can determine levels of understanding and possible misconceptions. Created works such as writing, drawing, video, or tape recordings are communications that provide recorded evidence of the learner's development, progress and growth.

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**Elaborate.** In stage four, Elaborate, the students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them. For example, while exploring light phenomena, a learner constructs an understanding of the path light travels through space. Examining a lamp post, she may notice that the shadow of the post changes its location as the day grows later. This observation can lead to further inquiry as to possible connections between the shadow's changing location and the changes in direction of the light source, the Sun. Applications to real world events, such as where to plant flowers so that they receive sunlight most of the day, or how to prop up a beach umbrella for shade from the Sun, are both extensions and applications of the concept that light travels in a straight path. These connections often lead to further inquiry and new understandings.

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**Evaluate.** Evaluate, the fifth "E", is an on-going diagnostic process that allows the teacher to determine if the learner has attained understanding of concepts and knowledge. Evaluation and assessment can occur at all points along the continuum of the instructional process. Some of the

tools that assist in this diagnostic process are: rubrics (quantified and prioritized outcome expectations) determined hand-in-hand with the lesson design, teacher observation structured by checklists, student interviews, portfolios designed with specific purposes, project and problem-based learning products, and embedded assessments. Concrete evidence of the learning process is most valuable in communications between students, teachers, parents and administrators. Displays of attainment and progress enhance understanding for all parties involved in the educational process, and can become jumping off points for further enrichment of the students' education. These evidences of learning serve to guide the teacher in further lesson planning and may signal the need for modification and change of direction. For example, if a teacher perceives clear evidence of misconception, then he/she can revisit the concept to enhance clearer understanding. If the students show profound interest in a branching direction of inquiry, the teacher can consider refocusing the investigation to take advantage of this high level of interest.

Viewing the evaluation process as a continuous one gives the constructivistic philosophy a kind of cyclical structure. The learning process is open-ended and open to change. There is an ongoing loop where questions lead to answers but more questions and instruction is driven by both predetermined lesson design and the inquiry process.