Making Mathematics Meaningful

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Often we hear elementary students make comments such as, "Why do I have to learn this?" "I'll never use this!" Or, "I can't remember the rule." Students often generate these comments when learning and doing math because they do not always understand the relevancy and significance of math. They realize that acquiring reading skills can result in additional knowledge; and with knowledge of history, they can possess an understanding of how the past influences the present; and, that knowledge acquired through experiments in science can often lead to new discoveries and inventions. But, elementary students often see math as boring and meaningless. This article will discuss a teaching model that promotes discovery as well as relevancy of math concepts. This model is called the learning cycle lesson format.

The learning cycle lesson format originated in the early 60s as the teaching model used in the Science Curriculum Improvement Study (SCIS) program. The launching of the Soviet satellite Sputnik in 1957 resulted in considerable funding provided for mathematics and science education programs in order for the United States to remain competitive in the space race. The SCIS program, having the greatest overall effect on student achievement, was one of numerous innovative science programs that resulted from this funding. SCIS was directed by Robert Karplus, field tested during the 60s, revised during the 70s, and is still in existence today. The goal of the SCIS program is to help learners form a broad conceptual framework for understanding science through exploration and discovery while taking ownership of concepts (Martin, Sexton, Wagner, and Gerlovich, 1997). The SCIS program emphasizes both process and content as students explore and discover concepts while the teacher acts as a facilitator and guide.

The original learning cycle model from the SCIS program consisted of three distinct phases: Exploration, Invention and Application. The Exploration phase was activity oriented and permitted learners to explore learning materials or phenomena. The Invention phase guided learners toward concepts by gathering results of their observations to invent ideas that assisted them in understanding their exploratory experiences. The Application phase provided opportunities for learners to broaden their experiences by using newly formed concepts in context (Martin ET al, 1997). The current SCIS program, also called the 4 E model, includes four phases: Exploration, Explanation, Expansion, and Evaluation. Since the learning cycle lesson format was introduced, many renditions have been created.

One learning cycle rendition is the 5 E model. When I began teaching in the early 70s, I used the three phase SCIS program model for teaching science concepts to elementary students. Today, I experiment with the 5 E model for teaching ECE 4401 Teaching Mathematics in Early Childhood Education. The 5 E model includes five phases: Engagement, Exploration, Explanation, Expansion and Evaluation. The Engagement phase acts as a motivator or focus for each lesson. For example, the teacher asks a question, presents a discrepant event/scenario, and/or shares a picture/word that initiates thinking on the part of the learners. This phase can also be used to assess students' current knowledge base. As students respond to the motivation phase, the teacher can gradually move forward to the next phase, Exploration. During the Exploration phase, the teacher provides concrete experiences in order to stimulate learner disequilibrium and foster assimilation (Martin et al, 1997). The teacher/instructor provides basic instructions for material use and then allows learners to explore and discover concepts while manipulating materials provided. The Exploration phase is learner-centered. During the third phase, Explanation, the teacher, through questioning, asks learners to provide information they have collected during the exploration phase. At this time, the teacher guides students in processing and mentally organizing their discovered knowledge. The concept is then constructed cooperatively and an appropriate label for the concept is applied. Although often used within the social studies curriculum, Hilda Taba and her associates promoted questioning strategies appropriate for the explanation phase that identify what students have learned as a result of experiencing an event. Taba's questioning strategies encourage all students to participate in discussions. Questions such as "What comes to mind when you think of _____?" "What did you think of when you heard/saw _____?" "Why did your group _____ in that way?" and "What conclusion(s) could we draw from our investigation?" (Martorella, 1998). Such questions during the explanation phase encourage openness and challenge students' thinking. Next, during the Expansion phase, the teacher provides learners with an opportunity to expand their newly acquired concept(s) through additional explorations and experiences. Concept labels are used and knowledge is applied to real-world experiences and/or career awareness instilling relevancy for math concepts. Although listed as the fifth phase, Evaluation occurs throughout all phases of the 5 E model in the form of teacher/student questions, discussions, interviews, teacher created observation checklists/rating scales, and/or student presentations or projects. Both informal and formal assessment can be included as part of the evaluation phase.

The 5 E learning cycle model has provided ECE 4401 math methods students with opportunities to discover and understand early childhood/elementary math con-

cepts. As a result, when learning occurs, preservice teachers take ownership of math concepts and appear to feel more comfortable with their mathematics abilities as they enthusiastically share their understanding of math concepts with their classmates. An example when using the 5 E model in ECE 4401 involves preservice educators' exposure to various interpretations for the basic math operations of addition, subtraction, multiplication and division. When following the 5 E model, students have an opportunity to draw on their prior knowledge and discover math operation interpretations on their own. As a result of their explorations with manipulatives, through instructor guidance, university students based on their perspectives define concepts and suggest appropriate labels. To their amazement, their definitions are accurate and as a result, a strong sense of conceptual ownership occurs. At this time, university students are provided with additional opportunities to expand their ideas reinforcing their conceptual understanding. Furthermore, students have an opportunity to share how they actually use discovered math concepts on a daily basis. Careers utilizing defined math concepts are also discussed providing a strong sense of relevancy.

A more specific math example would be understanding rational numbers, which is often challenging for both children and adults. With the use of the 5 E model, university math methods students have an opportunity to explore and discover number relationships through the use of manipulatives, in turn, constructing and defining conceptual understandings of fractions, decimals and percents. This knowledge is then expanded through additional experiences that provide students with opportunities to tie rational number concepts to real world experiences and career opportunities such as recipes, sewing, gardening, medicine, construction, hourly wages, track and field events, scale drawings, measurement, probability, statistics, graphing, and the stock market (Sheffield and Cruikshank, 1996).

Although the learning cycle lesson format originated to increase the effectiveness of teaching elementary science concepts, I have found it to be an extremely effective model for instructing university students in ECE 4401 Teaching Mathematics in Early Childhood Education. Hopefully, as students at all levels define and take ownership of math concepts through exploration and discovery utilizing the 5 E learning cycle model, they will develop solid links to real-world experiences and career opportunities, creating a strong sense of relevancy. If so, perhaps students' questions concerning the value of math will then have been successfully addressed.