THE BSCS 5E INSTRUCTIONAL MODEL AND 21ST CENTURY SKILLS

A Presentation for a Workshop on Exploring the Intersection of Science Education and the Development of 21st Century Skills

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INTRODUCTION

- Challenges that interested some science educators
- Intersections of calls for 21st Century skills with science education
- Descriptions of 21st Century skills
- Connections of science education and the development of 21st Century skills
- Evaluations of science education's curriculum programs and instructional practices designed to develop 21st Century skills

THE BSCS 5E INSTRUCTIONAL MODEL

- History of Instructional Models
- Science Curriculum Improvement Study (SCIS)
  - J. Myron Atkin and Robert Karplus (1962)
  - Robert Karplus and Herb Thier (1967)
  - SCIS Learning Cycle
  - Explore—Invent—Discover
- Development of the BSCS Model
  - Added Engage and Evaluate
  - Changed Invent to Explain
  - Changed Discover to Elaborate

THE BSCS 5E INSTRUCTIONAL MODEL

Phase	Summary
Engagement	The teacher or a curriculum task assesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Exploration	Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
Explanation	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaboration	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluation	The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

RESEARCH ON ***HOW PEOPLE LEARN***

An alternative to simply progressing through a series of exercises that derive from a scope and sequence chart is to expose students to the major patterns of a subject domain as they arise naturally in problem situations. Activities can be structured so that students are able to explore, explain, extend, and evaluate their progress. Ideas are best introduced when students see a need or a reason for their use—this helps them see relevant uses of the knowledge to make sense of what they are learning.

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Bransford, Brown, & Cocking (1999). *How People Learn*, p. 127.

RESEARCH ON INSTRUCTION

Integrated instructional units interweave laboratory experiences with other types of science learning activities, including lectures, reading, and discussion. Students are engaged in forming research questions, designing and executing experiments, gathering and analyzing data, and constructing arguments and conclusions as they carry out investigations. Diagnostic, formative assessments are embedded into the instructional sequence and can be used to gauge the students' developing understanding and to promote their self-reflection of their thinking.

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National Research Council (2006). *America's Lab Report: Investigations in High School Science*, p. 82.

RESEARCH ON THE BSCS 5E INSTRUCTIONAL MODEL

- *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications* (Bybee, et al., 2006)
- The findings suggest that, like its predecessor the SCIS Learning Cycle, the BSCS 5E instructional model is more effective than alternative teaching methods in helping students attain learning outcomes in science.

FIDELITY TO THE INSTRUCTIONAL MODEL: A KEY FINDING ABOUT EFFECTIVENESS

Students whose teachers taught with medium or high levels of fidelity to the BSCS 5E instructional model exhibited learning gains that were nearly double that of students whose teachers did not use the model or used it with low levels of fidelity.

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Coulson (2002)
Taylor, Van Scotter, & Coulson (2007)

LINKING THE BSCS 5E INSTRUCTIONAL MODEL TO 21ST CENTURY SKILLS

ADAPTABILITY

- No studies

COMPLEX COMMUNICATION/SOCIAL SKILLS

- Boddy, Watson, and Aubusson (2003)—reported increased higher-order thinking.
- Wilson, Taylor, Kowalski, & Carlson (accepted for publication 2009)—found support for argumentation.

LINKING THE BSCS 5E INSTRUCTIONAL MODEL TO 21ST CENTURY SKILLS

NON-ROUTINE PROBLEM SOLVING

- Wilson, et al. (in press)—support for scientific reasoning
- Taylor, et al. (2007)—support for applying understanding to new situations
- Boddy, et al. (2003)—support for higher-order thinking

SELF MANAGEMENT/SELF DEVELOPMENT

- Von Secker (2002)—support for increased interest
- Akar (2005)—support for increased interest
- Tinnin (2000)—support for increased interest

LINKING THE BSCS 5E INSTRUCTIONAL MODEL TO 21ST CENTURY SKILLS

SYSTEMS THINKING

- Bybee, et al. (2006)
- Coulson (2002)
- Taylor, et al. (2007)
- Akar (2005)
- Wilson, et al. (in press)

All found support for the efficacy of the BSCS model to enhance students' mastery of scientific subject matter.

INFERENCES FOR THE EFFECTIVENESS OF THE BSCS 5E INSTRUCTIONAL MODEL AND DEVELOPMENT OF 21ST CENTURY SKILLS

GOAL OF 21ST CENTURY SKILL	BSCS 5E INSTRUCTIONAL MODEL
ADAPTABILITY	Inadequate Evidence
COMPLEX COMMUNICATION	Some Evidence Based on Argumentation
NON-ROUTINE PROBLEM SOLVING	Strong Evidence Based on Scientific Reasoning
SELF MANAGEMENT/SELF DEVELOPMENT	Strong Evidence Based on Attitudes Toward and Interest in Science
SYSTEMS THINKING	Strong Evidence for Mastery of Scientific Subject Matter

THE BSCS 5E INSTRUCTIONAL MODEL AND DEVELOPMENT OF 21ST CENTURY SKILLS: A CONCLUDING DISCUSSION

- GENERAL OBSERVATIONS
- CURRICULUM GOALS
- ALIGNMENT WITH LEARNING RESEARCH
- ASSESSMENT AND EVIDENCE
- EFFECTIVENESS AND IMPLICATIONS

THE BSCS 5E INSTRUCTIONAL MODEL AND DEVELOPMENT OF 21ST CENTURY SKILLS: A CONCLUDING DISCUSSION

DESIGN PRINCIPLES THAT ACCOUNT FOR THE BSCS MODEL'S IMPACT AND EFFICACY

- The model is understandable, usable, and manageable by teachers.
- The integrated instructional sequence provides appropriate challenges, ample time, and adequate opportunities for student learning.

CONCLUSION