

Section

5

Appendix A1

Deliverables: Science and Mathematics Competencies (Conceptual Understanding)

Conceptual Understanding: Science Knowledge Base for Elementary Teacher Candidates

The following are based upon the *National Science Education Standards*, which has been adopted by *INTASC* Standards for Elementary Teachers:

Candidates understand the unifying concepts and processes that underlie the scientific disciplines: systems, order, organization; evidence, models, explanation; change, constancy and measurement; evolution and equilibrium; form and function

Candidates understand science as inquiry: observing objects and events in sequence and finding patterns and relationships between and among observed phenomena; raising questions; hypothesizing and predicting; using the process and tools of inquiry, including designing and conducting scientific investigations, making models, and analyzing data

Candidates demonstrate conceptual understanding of scientific concepts in three science content strands typically taught at the elementary grade levels:

Life Sciences (Characteristics of living things; life cycles of organisms; organisms and environments; populations and ecosystems; adaptation)

Strand 2: Physical Sciences (properties of objects and materials; position and motion of objects; light, heat, electricity, magnetism; motions and forces; transfer of energy)

Strand: 3 Earth and Space Science (properties of earth materials; objects in the sky; changes in earth & sky; earth in the solar system)

Common Misconceptions in Science

A review of the literature on science misconceptions revealed a wide variety of findings. The list below represents the findings of one study (Schoon & Boone, 1998). The findings of this study are included here because (1) the study was published in a peer reviewed journal, (2) the study was conducted among elementary preservice teachers, (3) the findings identified common misconceptions in life, physical, and earth/space sciences, and (4) the study assessed teachers' understanding of science misconceptions identified in previous research. This list is intended to guide future course development and assist instructors and course developers in identifying particular science content that has been more commonly misunderstood. We caution, however, that simply "knowing the facts" is not an indicator of conceptual understanding.

Science Misconceptions (Schoon & Boone, 1998)

The sun is straight up at noon.

Summer occurs when the earth is nearer the sun

The earth's shadow causes lunar phases

Heavier balls fall faster than similar lighter balls

Venous blood is blue

Rusted iron weighs less than the iron weighed before rusting

Any mineral that scratches glass is a diamond

Objects dropped from airplanes hit the ground immediately below the point where they were dropped

Venus, Mars, and Jupiter can only be seen with a telescope

Plants get their food from the soil

Electric appliances "use up" electricity

North is toward the top of a map of Antarctica

Dinosaurs lived at the same time as prehistoric man

Conceptual Understanding: Mathematics Knowledge Base for Elementary Teacher Candidates

Based on the NCTM Standards and the CT Frameworks, elementary teacher candidates must be able to:

Reason mathematically (number sense and operations)

See patterns

Solve problems

Rather than focus on specific content strands, we designed our mathematics assessment on a wide range of concepts and skills traditionally taught at the elementary level. The development of the mathematics assessment was guided by the CT Mathematics Curriculum Framework (Please see Section 2.VI. Mathematics Alignment for the specific skills, concepts, and competencies assessed).

In addition, through a literature review, we have identified critical content that may assist teacher educators in designing mathematics strategy courses emphasizing specific content strands. The concept of rational numbers forms the basis of most elementary mathematics curricula (Behr, Lesh, Post & Silver, 1983). The concept of rational numbers includes:

Part-whole relationships

Ratio

Rate

Quotient

Number line

Decimals

Functional relation

Common Misconceptions in Mathematics

The literature on misconceptions in the area of mathematics consistently identified several common misconceptions. Although we have cited only a few studies below, the misconceptions listed below have been identified in more than one study. This list is intended to guide future course development and assist instructors and course developers in identifying particular concepts that have been commonly misunderstood.

Misconceptions:

It is impossible to divide a small number by a larger number (Fischbein, Deri, Nello, & Marino, 1985)

Division and subtraction are commutative (Hart, 1981)

Division always makes smaller (Tirosh, 2000)

Shorter is always larger (Stacey, Steinle, Baturo, Irwin, & Bana, 2001)

Multiplication always makes bigger (Graeber, 1993)