

Objectives for Math 202: Mathematics for Elementary Teachers

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It is essential for students in the elementary grades to study mathematics for an hour a day under the guidance of teachers who enjoy mathematics and are prepared to teach it well.

–National Council of Teachers of Mathematics

Math 202 is the second in a two-part sequence of courses (together with Math 101) required for Elementary Education majors at the University of Evansville. The topics include properties of the number system, including the development of the real numbers, beginning with whole numbers; ideas from elementary number theory, covering divisibility, least common multiples and greatest common divisors; and topics from geometry, such as 2- and 3-dimensional shapes, and measurement. Emphasis is placed on problem solving techniques and communicating mathematical ideas. This course is intended to empower the prospective teacher to answer the “why” questions that will inevitably arise in the classroom. We will make no attempt to address the “how” or “when” questions; a course in methods will focus on pedagogical techniques for the classroom and curriculum issues will be decided by the school board for the district in which the teacher is employed.

The overall goal of the course is *understand* elementary mathematics. This means much more than attaining a satisfactory level of computational fluency. Certainly the prospective teacher will need to be comfortable performing arithmetic computation using a variety of algorithms and tools; she will also need to understand—and be able to explain to her students or peers—how the algorithm is consistent with the definition of the operation

being performed. For example, the prospective teacher should be able to explain, in clear mathematical terms, how the traditional algorithm for multiplication is an extension of the known properties of multiplication of whole numbers. Too often there is insufficient distinction made among the definition of an arithmetic operation, the properties of that operation (which follow from the definition) and the algorithms used for computation.

Another notion that this course will attempt to address is the misconception that justification is the same as proof. Students (of all ages and a variety of backgrounds) often claim that if a conjecture holds for a particular case, it must be true in general. While there are few instances when an elementary school teacher will be expected to provide a rigorous mathematical proof, it is important that she understand (and convey to her students) that examining a simple case or two does not constitute a proof. As an example, consider the rule for divisibility by 3 (or 9). The rule is easy to state and not significantly harder to justify (using the distributive property) for a three or four digit example. However, a rigorous proof that this conjecture holds for all whole numbers is notationally cumbersome and beyond the scope of elementary teacher training. Upon successful completion of the course, the prospective teacher should be able to provide age-appropriate mathematical justification based on the definitions and properties of the concepts involved; moreover, she should use care to avoid calling such a justification a “proof.”

To reach our goals, we will follow the guidelines adopted by the Indiana State Board of Education in *Indiana’s Academic Standards*. The complete standards (for all subject areas and grade levels) are available electronically at www.indianastandards.org. The topics covered in the two-course sequence coincide with the five Content Standards:

- Number and Operation, development of number sense is essential to mathematical thinking;
- Algebra, including algebraic thinking in recognizing patterns, relations and function, *not* just limited to formal algebra taught at the middle and high school level;
- Geometry, again not restricted to the rigorous geometric proof taught in middle and high school, but including spatial sense and shape recognition;

- Measurement, understanding measurable attributes and using appropriate tools for their measurement; and
- Data Analysis and Probability, making sense of the large amount of information we receive.

The exploration of number sense makes up a large portion of the course. Careful development of the number systems (whole, integer, rational and real) provides an essential foundation upon which the concepts of arithmetic and algebraic thinking can be built. Geometry and measurement (particularly the relations among linear, area and volume measurements) round out the course. Care should be taken to give mathematically sound statements of definitions and properties throughout.

Presentation of the content should reflect the five Process Standards:

- Problem Solving, developing techniques and strategies when the process is not known in advance;
- Communication, communicating mathematical thinking clearly;
- Reasoning and Proof, making mathematical conjectures and developing mathematical arguments;
- Connections, viewing mathematics and an integrated field of study; and
- Representation, using conventional and original representations to communicate mathematical ideas.

An emphasis on problem solving will provide an environment where the prospective teacher can learn with understanding. Too often, mathematics is “learned” through the memorization of facts, algorithms and techniques with little understanding of the underlying principles. Applying mathematics will feed the intuition and enable students to make connections among

the different concepts. A goal of this course is for students to know when and how to apply what mathematical knowledge they possess. Working on problem solving in groups enables the development of communication skills. Since prospective teacher will need to provide clear and accurate descriptions of mathematical ideas, group work should be considered an integral part of this course.

Students in Math 202 should *not* expect a methods course; nor should they expect a review of elementary school mathematics. The course is designed to increase the understanding of the mathematics upon which the elementary curriculum is based and to extend the prospective teacher's knowledge of general mathematics. When little Suzy asks "why," her teacher will be able to supply a better answer than "because."