

# Rubrics For Math 306

## 1 Relevant Student Learning Outcomes (SLOs)

In discussion with the faculty, the undergraduate committee created the student learning outcomes for the math education majors. The following SLOs are pertinent to the course content in Math 306.

1. Understand the role of definitions, axioms, and theorems in mathematical work. Recognize whether or not an argument is a valid proof. Produce viable proofs on your own with an appreciation of careful use of language.
2. Demonstrate an understanding of different models of geometry, both Euclidean and non-Euclidean. In particular, understand the real numbers and the cartesian plane geometrically.
3. Demonstrate an understanding of the importance that functions play in connecting topics across the high school curriculum.
4. Demonstrate effective written mathematical communication.

Math 306 offers several opportunities for creating exam questions which assess student performance in these areas. Outcomes #1 and #4 will be naturally be assessed in many homework and exam questions. Outcome #2 can be assessed by having students prove statements where implementing coordinates is a natural approach. Outcome #3 can be assessed by having students consider problems involving transformations.

Every instructor for Math 306 is asked to report on the performance of these students in achieving these outcomes. Instructors will be asked to separate the results from different concentrations and majors. To that end, students should be asked to self-identify which major or concentration they have declared, perhaps with a question on the first exam or on a survey administered to the class.

In addition to the SLOs listed above, instructors will be asked to aggregate the results from homeworks and examinations and assess student progress towards the following broad outcomes.

5. Demonstrate sufficient preparation in higher level mathematics to become successful high school math teachers.

These are program level SLOs written out verbatim; it is understood that Math 306 instructors will be limited to commenting on preparation in teaching geometry classes.

Finally, instructors should ask students to self-assess their performance on these SLOs through questions on an electronically administered survey.

## 2 Rubrics

The purpose of the rubrics is to ensure that assessment occurs independently from the instructor's chosen grading scale. For example, some instructors may view that a student who gets 80-90% of the points to have given a "very good" solution while others may expect 100% credit to be rated at this level, using the "excellent" rating to distinguish exceptional solutions.

### 2.1 Rubric for SLO #1:

Understand the role of definitions, axioms, and theorems in mathematical work. Recognize whether or not an argument is a valid proof. Produce viable proofs on your own with an appreciation of careful use of language.

Excellent	Reasoning is complete and fully explained. Results which are being used are clearly stated and the argument is well organized. All mathematical terms are used precisely, including symbols and words. Argument shows a solid understanding of mathematical structures.
Very Good	Overall argument is clear but may be missing some minor details. Most results used in the argument are stated. Mathematical language is used well, perhaps with occasional imprecision. Student may lack broad understanding of how a problem or result fits into the bigger picture.
Satisfactory	Fundamental steps in argument are present but may lack clarity. Student rarely states axioms, definitions, and prior results. Precision in language and symbols may frequently be lacking. Student probably does not use larger structures or connections between ideas and results.
Questionable	Argument is flawed, either logically or in the way it is presented or both. Student does not state hypotheses or conclusions clearly and conclusions are sometimes incorrect. Argument shows little understanding of how the result in question fits into a bigger structure.
Unacceptable	Argument is incomplete or incorrect. Student does not explain reasoning adequately and language may be sloppy or incorrect. Work does not show an understanding of the material or of how to write a convincing, cogent argument.

## 2.2 Rubric for SLO #2:

Demonstrate an understanding of different models of geometry, both Euclidean and non-Euclidean. In particular, understand the real numbers and the cartesian plane geometrically.

Excellent	Understands how to compute lengths and determine angles in Euclidean and non-Euclidean geometries. Is able to represent geometric transformations algebraically. Is able to interpret algebraic equations geometrically. Is able to use vectors to represent geometric situations. Carefully defines variables when using coordinates.
Very Good	Can often compute lengths and determine angles in Euclidean and non-Euclidean geometries. Often able to represent geometric transformations algebraically. Is able to interpret algebraic equations geometrically. Usually defines variables when working in coordinates.
Satisfactory	Can often compute lengths and determine angles in Euclidean and non-Euclidean geometries. Struggles to view transformations as functions. Understands the meaning of variables when working with coordinates.
Questionable	Can follow reasoning with coordinates and transformations in a coordinate system but has difficulty computing lengths and determine angles in Euclidean and non-Euclidean geometries. Careless in use of variables when working in a coordinate system.
Unacceptable	Has difficulty using coordinates to solve problems, with or without transformations. Does not understand the link between transformations and functions. Is sloppy with use of variables representing coordinates.

### 2.3 Rubric for SLO #3:

Demonstrate an understanding of the importance that functions play in connecting topics across the high school curriculum.

Excellent	Understands how to use transformations, coordinates, and vectors in the plane to solve problems in $\mathbb{R}^2$ and $\mathbb{R}^3$ . Works fluently with transformations applied to shapes in the plane to show congruence and similarity. Comfortably and confidently applies transformations to prove theorems (e.g. base angles in an isosceles triangle are congruent).
Very Good	Works with transformations but does not necessarily understand them well as functions. Can apply a transformation to points and polygons. Understands geometric proofs that use transformations.
Satisfactory	Can understand some calculations and arguments with transformations but is unable to consistently make these calculations or produce successful arguments using transformations.
Questionable	Can successfully apply some transformations (especially translations) to points. Struggles to use transformations as a tool in proofs and lacks understanding of a transformation as a mathematical object, i.e. a function.
Unacceptable	Can not successfully apply transformations to points or shapes. Does not understand how to use transformations to show congruence or similarity of shapes.

## 2.4 Rubric for SLO #4:

Demonstrate effective written mathematical communication.

Excellent	Uses mathematical language precisely. Constructs clear arguments which communicate a line of reasoning to others. States all hypotheses clearly and records measurements and calculations with an appropriate level of precision. Can interpret written reasoning of other students even if they are unable to formulate their thought precisely.
Very Good	Uses mathematical language well. Constructs good arguments with an occasional missing step or flaw. States many hypotheses and often records measurements and calculations with an appropriate level of precision. Can sometimes interpret written reasoning of other students.
Satisfactory	Sometimes uses mathematical language well. Can not always distinguish a good argument from a bad argument and presents both good and bad arguments. Frequently omits important hypotheses and records measurements and calculations with an inappropriate level of precision.
Questionable	Is often faulty and imprecise in use of mathematical language. Frequently presents bad or flawed reasoning. Does not understand the importance of stating hypotheses or recording measurements with appropriate precision.
Unacceptable	Unable to use appropriate mathematical language in arguments. Unable to construct or identify cogent arguments.

## 2.5 Rubric for SLO #5:

Demonstrate sufficient preparation in higher level mathematics to become successful high school math teachers.

Excellent	Understands the mathematical foundations of high school geometry, including working with rigid motions and dilations to show congruence and similarity of shapes in the plane. Understands real number line and understands the Euclidean plane both as an abstract object and as the real plane. Understands trigonometric functions and their geometric properties.
Very Good	Can reason about congruence and similarity of shapes but is not confident with the definitions and arguments using rigid motions and dilations. Can work with real numbers and points in the plane. Knows definitions and basic properties of trigonometric functions.
Satisfactory	Can identify when shapes are congruent or similar but can not always present a cogent mathematical argument. Has familiarity with real number line and plane but not a deep mathematical understanding. Has some familiarity with basic trigonometric functions.
Questionable	Can sometimes identify when shapes are congruent or similar. Does not have a good understanding of the real number line, the Euclidean plane, or their mathematical properties. Does not understand many aspects of trigonometric functions or their properties.
Unacceptable	Does not understand how to show that two shapes are congruent or similar. Does not understand the real line or the plane. Does not understand the trigonometric functions or their properties.