Section IV Evidence for Meeting Standards
#2 Secondary Mathematics Content Portfolio

1. Description of Assessment: Secondary Mathematics Content Portfolio

The Secondary Mathematics Content Portfolio, which is submitted to the instructor during SED 410 Practicum in the semester prior to student teaching, contains artifacts in six categories of mathematics in which candidates showcase their knowledge of and best work in mathematics from their undergraduate program and a reflective essay through which candidates describe how the artifacts demonstrate their growth over time. It is expected that selections reveal a breadth of knowledge across several areas of mathematics; it is intended that the compilation creates a culminating mathematics experience. All undergraduate teacher candidates complete artifacts in all courses for every category; they select and submit artifacts from different courses in each category. Teacher candidates in the Rhode Island Teacher Education (RITE, for certification only) and Master of Arts in Teaching (MAT) programs submit only the Performance Task (Section 6) since their mathematics coursework is usually completed prior to admission. Accommodations are made for transfer students who may lack some artifacts.

2. Alignment of Secondary Mathematics Content Portfolio with NCTM Standards and Indicators

Program Standard	Indicators Addressed
Standard 1: Knowledge of Mathematical Problem Solving	1.1, 1.2, 1.3, 1.4
Standard 2: Knowledge of Reasoning and Proof	2.1, 2.2,, 2.3, 2.4
Standard 3: Knowledge of Mathematical Communication	3.1, 3.2, 3.3
Standard 4: Knowledge of Mathematical Connections	4.1, 4.2, 4.3
Standard 5: Knowledge of Mathematical Representation	5.1, 5.2
Standard 6: Knowledge of Technology	6.1
Standard 7: Dispositions	none
Standard 8: Knowledge of Mathematics Pedagogy	none
Standard 9: Knowledge of Number and Operation	9.2, 9.5, 9.7, 9.9, 9.10*
Standard 10: Knowledge of Different Perspectives on Algebra	10.2, 10.3, 10.4, 10.5, 10.6*
Standard 11: Knowledge of Geometries	11.1, 11.2, 11.7, 11.8*
Standard 12: Knowledge of Calculus	12.1, 12.2, 12.4, 12.5*
Standard 13: Knowledge of Discrete Mathematics	13.1, 13.4*
Standard 14: Knowledge of Data Analysis, Statistics, and Probability	14.6
Standard 15: Knowledge of Measurement	15.2, 15.4*

*Assignments from the History of Mathematics course (MATH 458) vary in area of mathematics selected. This indicator applies to that assignment. See sample below.

3. Data Results

The intent of the portfolio is for students to reflect their growth in mathematics over time by re-examining their work and to select examples of their best work for inclusion. Because there is choice of courses for each mathematics section, and most courses contain several tasks considered suitable for a portfolio artifact, rarely is an artifact submitted that earns a rubric score less than 3. The reflective essay is assessed and the overall portfolio is examined for completeness. No reflective essays or portfolios have been submitted that have earned below 3.

4. Data Interpretation

About 90% of teacher candidates who complete the program earn an overall score of 3 on this assessment. The remaining candidates who earn a score of 4 do so because both their work and essay are exceptional (mostly 4 on mathematics artifacts and 4 on essay). The design of assessment tasks allow candidates to demonstrate their knowledge of problem solving and their ability to conjecture and prove mathematical statements, to communicate mathematics effectively using appropriate representations and technology results, and to make connections within and outside of mathematics. In addition, they demonstrate knowledge contained in the content standards appropriate to the tasks.

5. Assessment Documentation

a. Mathematics Content Portfolio: 6 content categories

Instruction for Section 1. ***Exam items from the Calculus sequence (MATH 212 Calculus I or MATH 314 Calculus III). Instructors select and score problems that demonstrate a sampling of the purposes and goals of the course.***

NCTM Indicators
12.1 Demonstrate a conceptual understanding of and procedural facility with basic calculus concepts.
12.2 Apply concepts of function, geometry, and trigonometry in solving problems involving calculus.

Sample items: Calculus I

a) Given the following properties, sketch a possible graph of f .

$f(2) = -1$; $f'(2)$ is undefined; $f''(x) < 0$ on $(-\infty, 2)$; $f''(x) < 0$ on $(2, \infty)$

b) A rectangle is bounded by the x- and y-axes and the graph of $y = -x^2 + 9$. What length and width should the rectangle have so that its area is a maximum? (Fig a)

c) Given the graph of f', sketch a possible graph of f on the same axes. (Fig b)

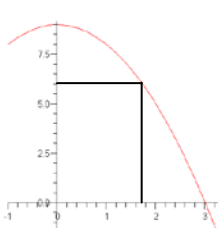

Fig a   Fig b

Sample items: Calculus III

a) Given the function $z = f(x; y) = x^3 - 3x^2 + y^2$,
   (i) Determine all critical point(s) of f(x; y).
   (ii) Determine all relative extrema of f(x; y).

b) Consider a solid bounded by the surface $z = \text{sqrt}(x^2 + y^2)$ and $z = 2$.
   (i) Sketch the solid as precisely as you can with the coordinate system and units clearly marked.
   (i) Set up a multiple integral for the volume of the solid and evaluate that integral.

Instruction for Section 2. ***Instructors in Linear Algebra (MATH 315) and Geometry (MATH 324) select and score problems from exams, homework, or special assignments that demonstrate a sampling of the purposes and goals of the course.***

NCTM Indicators appropriate for course selected:
2.4 Select and use various types of reasoning and methods of proof.
9.9 Recognize matrices and vectors as systems that have some of the properties of the real number system.
10.2 Apply fundamental ideas of linear algebra.
10.4 Use mathematical models to represent and understand quantitative relationships and in solving problems.
11.1Demonstrate knowledge of core concepts and principles of Euclidean and non-Euclidean geometries in two and three dimensions from both formal and informal perspectives.
11.2 Exhibit knowledge of the role of axiomatic systems and proofs in geometry.
11.7 Use concrete models, drawings, and dynamic geometric software to explore geometric ideas and their applications in real-world contexts.

Sample Items: Linear Algebra

$$\text{Let } A = \text{matrix} \begin{matrix} 1 & -1 & -1 & 2 \\ 2 & 5 & 12 & -3 \\ 3 & 1 & 5 & 2 \\ 1 & 2 & 5 & 3 \end{matrix}$$

a) Find a basis for Nul(A), Col(A).
b) Find the dimensions for Nul(A), Col(A).

Sample items: Geometry

a) Use coordinate geometry and paragraph style to prove the theorem, *the diagonals of a rhombus are perpendicular*. Write this carefully and thoroughly!

b) (i) Suppose that $AB = DE$, $BC = EF$ and $m < ABC = m < DEF$, is $\Delta ABC \cong \Delta DEF$ in Euclidean geometry? Explain or give a counter example.

(ii) Suppose that $AB = DE$, $BC = EF$ and $m < ABC = m < DEF$, is $\Delta ABC \cong \Delta DEF$ in Taxicab geometry? Explain or give a counter example.

<u>Instruction for Section 3.</u> Include an example of a mathematics problem that illustrates use of the graphing calculator or computer in the solution selected from technology assignments in the Calculus sequence (MATH 213, 314), Linear Algebra (MATH 315) or Geometry (MATH 324) and scored by the instructor.

<u>NCTM Indicators</u>:
2.4 Select and use various types of reasoning and methods of proof.
6.1 Use knowledge of mathematics to select and use appropriate technological tools, such as but not limited to, spreadsheets, dynamic graphing tools, computer algebra systems, dynamic statistical packages, graphing calculators, data-collection devices, and presentation software.
10.5 Use technological tools to explore algebraic ideas and representations of information and in solving problems.
11.7 Use concrete models, drawings, and dynamic geometric software to explore geometric ideas and their applications in real-world contexts.
12.4 Use technological tools to explore and represent fundamental concepts of calculus.
15.2 Apply appropriate techniques, tools, and formulas to determine measurements and their application in a variety of contexts.

<u>Samples of assignments</u>

<u>Calculus – arc length</u>

a) (i) Plot the following function and then use **estimation techniques** to **approximate** the length of the curve over the interval. $f(x) = 0.5x^2 + x\sin(x^2) + 8$ over $[0,4]$

(ii) Use the integration capabilities of Maple to find an excellent approximation of the arc length.

<u>Linear Algebra</u>

1. Let

$$A = \begin{pmatrix} a_0 & a_1 & 0 \\ 0 & a_0 & a_1 \\ b_0 & b_1 & b_2 \end{pmatrix}$$

$$B=\begin{pmatrix} a_0 & a_1 & a_2 & 0 \\ 0 & a_0 & a_1 & a_2 \\ b_0 & b_1 & b_2 & 0 \\ 0 & b_0 & b_1 & b_2 \end{pmatrix}$$

a) Use MAPLE to find the determinant of A.
b) USE MAPLE to find the determinant of B.

2. Continue with the determinants from above. We'll let

$$f(x)=a_0+a_1x \text{ and } g(x)=b_0+b_1x+b_2x^2$$

be two general polynomials of degree 1 and 2. So the determinant A above is determined by the coefficients of f and g. Thus we'll simply denote $\det(A)$ by $R(f,g)$ called "the resultant" of polynomials f,g, i.e. $\det(A)=R(f,g)$.

a) If we let $f(x)=(1-x), g(x)=(1-x)(4+x)$, find the corresponding determinant $R(f,g)$;
b) If $f(x)=(2-x), g(x)=(2-x)(4+x)$, find the corresponding determinant $R(f,g)$;
c) If $f(x)=(n+x)(x+m), g=(n+x)(m+x)$, find the corresponding determinant $R(f,g)$;
d) In general if the resultant $R(f,g)=0$, what can you say about the polynomials f and g ?
e) Furthermore can you say anything about the meaning of $\det(B)$?

Geometry

A 'bisectogram' is defined as a quadrilateral formed by the bisectors of the angles of a quadrilateral. Use Sketchpad to investigate:

a) Investigate the 'bisectogram' of a parallelogram. Does it have a name? Hand in a printout.
b) State a theorem based on your investigation.
c) Prove your theorem, using methods of Euclidean geometry.

Instruction for Section 4. ***Instructors suggest a project that either requires more time or addresses a side topic not covered in the class from a 400 - level mathematics course [Introduction to Operations Research (MATH 418), Number Theory (431), Introduction to Abstract Algebra (432), Discrete Mathematics (MATH 436), Introduction to Probability (MATH 441) or History of Mathematics (MATH 458)] that demonstrates problem-solving competence beyond what is typically assessed on in-class examinations.***

NCTM Indicators appropriate for course selected:

1.1 Apply and adapt a variety of appropriate strategies to solve problems.
1.2 Solve problems that arise in mathematics and those involving mathematics contexts.
1.3 Build new mathematical knowledge through problem solving.
2.4 Select and use various types of reasoning and methods of proof.
9.2 Use properties involving number and operations, mental computation, and computational estimation.

9.5 Apply the fundamental ideas of number theory.
9.7 Compare and contrast properties of numbers and number systems.
10.3 Apply the major concepts of abstract algebra to justify algebraic operations and formally analyze algebraic structures.
13.1 Demonstrate knowledge of basic elements of discrete mathematics such as graph theory, recurrence relations, finite difference approaches, linear programming, and combinatorics.
14.6 Draw conclusions involving uncertainty by using hands-on and computer-based simulation for estimating probabilities and gathering data to make inferences and conclusions.
9.10, 10.6, 11.8, 12.5, 13.4, 15.4
Demonstrate knowledge of the historical development of number and number systems (or algebra, Euclidean and non-Euclidean geometries, calculus, and measurement and measurement systems) including contributions from diverse cultures.

The samples that follow provide the reader with a sense of the breadth and depth of the artifact assignments in the named courses.

Introduction to Operations Research:
Use the diet problem solver (http://www.zweigmedia.com/RealWorld/dietProblem/diet.html) to formulate and solve your ideal diet.

a) Select at least 15 of the foods from the given list;
b) Solve using the following objectives: Minimum cost and Minimum calories.

Prepare a report that includes the following:
1. **The mathematical model** that includes decision variables, objective function, and structural constraints and short explanation of each;
2. **The solution** showing the objectives are met;
3. **A discussion and analysis of the solution, including**
   Why the two are the same or different;
   Whether you think this solution works for you;
   On the basis of this analysis, what you would change in the model.
   Rerun the solver with the change(s), and see whether your solution is improved and why.

Number Theory:
Definition: Let n be a positive integer. We define $\sigma(n)$ to be the sum of the positive divisors of n.
Example: $\sigma(40) = 1 + 2 + 4 + 5 + 8 + 10 + 20 + 40 = 90$.
a) (i) Make a table for $\sigma(n)$ as n runs from 1 to 30.
   (ii) What is the $\sigma(p)$, p prime? $\sigma(p^3)$? $\sigma(p^k)$ for any positive integer k?
   (iii) Is σ a multiplicative function? Justify your answer with a proof or counterexample.
   We say n is a perfect number in case $\sigma(n) = 2n$. If $\sigma(n) < 2n$, we say n is deficient and if $\sigma(n) > 2n$ we say n is abundant.
   (iv) Label each of the values n in the table as either abundant, deficient, or perfect.
   (v) Can you make any generalizations about which numbers in the table are always deficient? Try to prove your conjecture.

b) (i) Find the u and v that generate the Pythagorean triple (x,y,z) = (48,55,73).
   (ii) Find all primitive Pythagorean triples with the value of x being 12.

Introduction to Abstract Algebra:

Suppose G is a group under the operation &, and H is a group under the operation @. Consider the Cartesian Product G x H, and define an operation, * on G x H by: (*a, b*) * (*c,d*) = (*a* & *c*, *b* @ *d*)
Under this operation, G x G' is a group.

Part I.

1. (a) Make a Cayley Table for $\mathbf{Z}_3$ x < (1, 2, 3) > (with their usual associated binary operations)
   (b) What is the identity element of that group?
   (c) What is the inverse of ([2], (1, 2, 3))?
2. List the distinct cosets of < ([1], [3]) > in $\mathbf{Z}_2$ x $\mathbf{Z}_8^*$ ($\mathbf{Z}_8^*$ is the set of elements in $\mathbf{Z}_8$ that have multiplicative inverses.)
3. Find an isomorphism from $\mathbf{Z}_6$ to $\mathbf{Z}_3$ x $\mathbf{Z}_2$.
4. Let G = $\mathbf{Z}_4$ x $\mathbf{Z}_2$.
   (a) Find all the cyclic subgroups of G.
   (b) Find a non-cyclic subgroup of G, if such a subgroup exists.
   (c) Explain why G is not isomorphic to $\mathbf{Z}_8$.
   (d) Explain why G is not isomorphic to $\mathbf{Z}_2$ x $\mathbf{Z}_2$ x $\mathbf{Z}_2$.

Part II.

1. Let G and H be (abstract) groups.
   a) Describe the identity element of G x H.
   b) Describe the inverse of the element (*x, y*).
2. Prove that G x H is abelian if and only if both G and H are abelian.
3. a) Determine whether the following statement is true or false and explain your reasoning: If G is a cyclic group generated by a, and G' is a cyclic group generated by a', then G x G' is generated by (a, a').
   b) If *a* has order 8 in G, and *a*' has order 6 in G', make a conjecture as to the order of (*a, a'*).
4. Consider H = {(*x, e'*) : *x* ε G}, a subset of G x G'. (Note that G and G' are abstract groups and that e' is the identity element in G'
   a) If G = **R** (with operation +), and G' = **R** (with operation +), describe the graph of H in the Cartesian plane.
   b) In general, prove that H is a subgroup of G x G'.
   c) In general, prove that φ : H → G' defined by φ (*x*, e') = *x* is an isomorphism.

Discrete Mathematics:

The side length of a square ABCD, 8 units, is a Fibonacci number. Points E and F are drawn 3 units from vertices A and D on sides AB and CD respectively and joined, resulting in two rectangles AEFD (3 units x 8 units) and EBCF (5 units by 8 units). The diagonal AF is added to rectangle AEFD. Point G is drawn on segment BC 3 units from B; similarly, point H is drawn on segment EF 3 units from F. Draw the segment GH, resulting in congruent trapezoids. Cut the four pieces and rearrange them to make a rectangular shape that is 5 units x 13 units.

a) Determine the area of the square and rectangular shape. What do you find? How can you explain it?
b) Repeat the construction, but start with a square whose side length is 13, another Fibonacci number. Determine the areas of the square and rectangular shape. What do you find? How can you explain it?

c) Determine whether this phenomenon exists if the side length of the original square is not a Fibonacci number.

c) Consider other squares whose side lengths are Fibonacci numbers and form a conjecture about the general case, the start of which might be, "for consecutive Fibonacci numbers x, y and x + y that are greater than 1, and x + y is the side of a square, then the area difference between the square and the rectangular shape can be expressed algebraically as…."

d) Prior to proving the conjecture, investigate the Fibonacci sequence (which is defined recursively) and its well-known properties. Include the results of your investigation as well as the proof of your conjecture.

Introduction to Probability:

Projects in this course require students to establish probability distributions of statistics that are not typically covered in the course, e.g. Minimum and the Maximum of Two Independent Random Variables, Median of an Odd Number of Independent Random Variables, or Sum of a Set of Random Variables. Projects guide students through some theory and ask them to apply the theory and solve some real-world problems. Candidates use their knowledge of calculus and Maple software in completing their project. A typical beginning paragraph of a project is summarized below.

> The goal is to establish the probability distribution of the [statistics of interest]. Begin by considering the case of independent and identically distributed random variables. Conceptually, the process is to construct the CDF of the given function of the random variables and then produce the PDF by differentiation.

History of Mathematics:

Although the idea of a limit was discussed by 18th and 19th century mathematicians, there were no formal definitions (e.g., sequence, function) until the 20th century when "rigor" was introduced into mathematics. Working directly from definitions, "rigorously" prove that the given functions and sequences have the indicated limits.

Function	Function Limit	Sequence	Sequence Limit
$f(x) = 8x-11$	$f(x) \to 5$ as $x \to 2$	$\{s_n\} = \frac{26n-4}{6n+5}$	$s_n \to \frac{13}{3}$
$f(x) = 12x-3$	$f(x) \to -15$ as $x \to -1$	$\{s_n\} = \frac{11n+4}{22n+5}$	$s_n \to \frac{1}{2}$
$f(x) = -8x-1$	$f(x) \to 7$ as $x \to -1$	$\{s_n\} = \frac{3n-4}{2n+15}$	$s_n \to \frac{3}{2}$
$f(x) = 4x+3$	$f(x) \to 39$ as $x \to 9$	$\{s_n\} = \frac{12n+13}{6n+2}$	$s_n \to 2$

***Instruction for Section 5.* A graded proof from a Bridge to Advanced Mathematics (MATH 300) examination or assignment that has been designated as a portfolio artifact by the instructor.**

NCTM Indicators

2.1 Recognize reasoning and proof as fundamental aspects of mathematics.
2.2 Make and investigate mathematical conjectures.
2.3 Develop and evaluate mathematical arguments and proofs.
2.4 Select and use various types of reasoning and methods of proof.
3.1 Communicate their mathematical thinking coherently and clearly to peers, faculty, and others.
3.2 Use the language of mathematics to express ideas precisely.
3.3 Organize mathematical thinking through communication.
5.2 Create and use representations to organize, record, and communicate mathematical ideas.

Samples

1. Let f be a function f: R $\rightarrow$ [2, symbol infinity) defined by f(x) = abs(x) + 2. Determine if f(x) is one-to-one, and/or onto. Justify your response with either a proof or counterexample.

2. For the following statement, write the contrapositive and the negation. If the statement is true, prove it; if the statement is false, provide a counterexample.

   "For real number x and y if x + y is irrational then either x or y is irrational."

3. Prove by induction: $1^2 + 2^2 + 3^2 + \ldots + n^2 = (n(n + 1)(n + 2))/6$ for all natural numbers n.

***Instruction for Section 6*. A performance (extended problem solving) task that is completed during a Practicum session.**

NCTM Indicators

1.1 Apply and adapt a variety of appropriate strategies to solve problems.
1.2 Solve problems that arise in mathematics and those involving mathematics contexts.
1.4 Monitor and reflect on the process of mathematical problem solving.
3.1 Communicate their mathematical thinking coherently and clearly to peers, faculty, and others.
3.2 Use the language of mathematics to express ideas precisely.
3.3 Organize mathematical thinking through communication.
4.1 Recognize and use connections among mathematical ideas.
4.2 Recognize and apply mathematics in contexts outside of mathematics.
4.3 Demonstrate how mathematical ideas interconnect and build on one another to produce a coherent whole.
5.1 Use representations to model and interpret physical, social, and mathematical phenomena.
5.2 Create and use representations to organize, record, and communicate mathematical ideas.

Sample Tasks

Tasks and rubrics that accompany them released by the New Standards Project for high school students continue to serve the goals of the program. Two are described briefly.

1. “Snark Soda”

The task requires using geometric shapes to model as closely as possible the volume of the liquid in the bottle illustrated. (Two pictures are provided: 1) a filled bottle of soda and 2) a view from the top of the bottle). Candidates are given two directions:

a) Use geometric shapes to figure out as accurately as you can a good approximation for the volume of the liquid in the bottle.
b) Discuss the accuracy of your model by talking about where it gives overestimates or underestimates.

The task specifies that candidates will be assessed on how clearly they show what they did using diagrams, formulas, and words; and how easy it would be for someone not present in class when the lesson was taught to repeat what the candidate did and check the approximation for the volume.

2. “Shoelaces”

The task requires candidates to develop a rule that predicts the length of shoelaces needed from the number of lace holes in the sneakers (up to ten pair of lace holes). They are expected to develop a table, graph and formula based on pictures that are provided. They are expected to design three signs to guide consumers purchase the correct length of shoelaces if they know the number of pair of lace holes in the sneakers; one using a table, a second using a graph, and a third using a formula.

Mathematics Content Portfolio: Reflective Essay

Instruction for Reflective Essay. ***Prepare a short essay that describes the selected artifacts and integrates them in a manner that showcases mathematical understanding and readiness to teach, and reflects on past mathematical growth and future learning.***

NCTM Indicators
3.1 Communicate their mathematical thinking coherently and clearly to peers, faculty, and others.
3.3 Organize mathematical thinking through communication.

b. Scoring Guide for Mathematics Content Portfolio

There are separate scoring guides for each mathematics course represented in the Content Portfolio. Prior to 2007, the rubrics were based on a 4-point (0 - 3) scale. At the request of mathematics faculty, they were changed to a 5-point (0 – 4) scale in spring 2006 to roughly align with letter grades A – F. The essay is assessed separately with a 4-point rubric with categories Exemplary, Acceptable, Revise/Resubmit, and Unacceptable. The Revise/Resubmit category is comparable to scores of 1 or 2 in the rubrics below. (ContentPortfolio_ReflectionRubric.doc) An overall portfolio rating, also on a 0 – 4 scale, is awarded based on overall quality in the six content sections and the essay, professional appearance, and inclusion of a current transcript with mathematics GPA calculated and documentation for the PRAXIS #0061 and Algebra & Trigonometry exams.

Calculus Rubric

4	Task solution demonstrates appropriate use and knowledge of calculus concepts and contains at most minor arithmetic errors. The narrative component explains the calculus concepts accurately and clearly; the writing demonstrates excellent standard English and mathematical notation.
3	Task solution demonstrates mostly appropriate use and knowledge of calculus concepts and contains some errors of substance. The explanation of the calculus concepts is mostly accurate and clear; the writing demonstrates good standard English and mathematical notation.
2	Task solution demonstrates moderate knowledge of calculus concepts and contains errors that reveal misconceptions. The explanation is sparse, may be unclear, and, when correct, reiterates text language; the writing includes some grammar and spelling errors.
1	Task solution demonstrates some knowledge of calculus concepts and contains conceptual and computation errors. The explanation is very incomplete, is unclear, and may be incorrect even when reiterating from the text; the writing includes grammar and spelling errors.
0	Task solution demonstrates little knowledge of calculus concepts and contains many conceptual and computation errors. The explanation is missing or minimal, is unclear, and is incorrect even when reiterating from the text; the writing includes major grammar and spelling errors.

Linear Algebra Rubric

4	Task solution demonstrates appropriate use and knowledge of linear algebra concepts and contains at most minor arithmetic errors. The narrative component explains the linear algebra concepts accurately and clearly; the writing demonstrates excellent standard English and mathematical notation.
3	Task solution demonstrates mostly appropriate use and knowledge of linear algebra concepts and contains some errors of substance. The explanation of linear algebra concepts is mostly accurate and clear; the writing demonstrates good standard English and mathematical notation.
2	Task solution demonstrates moderate knowledge of linear algebra concepts and contains errors that reveal misconceptions. The explanation is sparse, may be unclear, and, when correct, reiterates text language; the writing includes some grammar and spelling errors.
1	Task solution demonstrates some knowledge of linear algebra concepts and contains conceptual and computation errors. The explanation is very incomplete, is unclear, and may be incorrect even when reiterating from the text; the writing includes grammar and spelling errors.
0	Task solution demonstrates little knowledge of linear algebra concepts and contains many conceptual and computation errors. The explanation is missing or minimal, is unclear, and is incorrect even when reiterating from the text; the writing includes major grammar and spelling errors.

Geometry Rubric

4	Task solution demonstrates appropriate use and knowledge of geometry concepts and contains at most minor arithmetic errors. The narrative component explains the geometry concepts accurately and clearly; the writing demonstrates excellent standard English and mathematical notation.
3	Task solution demonstrates mostly appropriate use and knowledge of geometry concepts and contains some errors of substance. The explanation of geometry concepts is mostly accurate and clear; the writing that accompanies the solution is clear and demonstrates good standard English and mathematical notation.
2	Task solution demonstrates moderate knowledge of geometry concepts and contains errors that reveal misconceptions. The explanation is sparse, may be unclear, and, when correct, reiterates text language; the writing includes some grammar and spelling errors.
1	Task solution demonstrates some knowledge of geometry concepts and contains conceptual and computation errors. The explanation is very incomplete, is unclear, and may be incorrect even when reiterating from the text; the writing includes grammar and spelling errors.
0	Task solution demonstrates little knowledge of geometry concepts and contains many conceptual and computation errors. The explanation is missing or minimal, is unclear, and is incorrect even when reiterating from the text; the writing includes major grammar and spelling errors.

Technology Problem Rubric

4	The technology problem submission is complete and correct. It demonstrates excellent command of technology techniques and problem solving strategies. The writing that accompanies the solution is clear and demonstrates excellent standard English and mathematical notation.
3	The technology problem submission is mostly complete and correct. It demonstrates good command of technology techniques and problem solving strategies. The writing that accompanies the solution is clear and demonstrates good standard English and mathematical notation.
2	The technology problem submission is partially correct, which may be due to incomplete processing or incorrect technology commands or problem solving strategies. It demonstrates a fair command of technology techniques and problem solving strategies. The writing that accompanies the solution includes some grammar and spelling errors.
1	The technology problem submission is generally incorrect, which may be due to incomplete processing, incorrect technology commands, or incorrect problem solving strategies. It demonstrates a weak grasp of technology techniques and problem solving strategies. The writing that accompanies the solution includes grammar and spelling errors.
0	The technology problem submission is substantially incorrect. It demonstrates an unacceptable grasp of technology techniques and problem solving strategies. The writing that accompanies the solution includes major grammar and spelling errors.

Upper Level Course Project Rubric

4	Project solution demonstrates appropriate use and knowledge of the concepts of this upper level course, is a correct solution and contains at most minor arithmetic errors. The narrative component explains the upper level course concepts accurately and clearly; the writing demonstrates excellent standard English and mathematical notation.
3	Project solution demonstrates mostly appropriate use and knowledge of concepts of this upper level course, is a mostly correct solution but may contain some errors of substance. The explanation of the upper level course concepts is mostly accurate and clear; the writing demonstrates correct standard English with at most minor grammatical errors.
2	Project solution demonstrates moderate knowledge of the upper level course concepts, but the solution contains errors that reveal misconceptions. The explanation of the upper level course concepts is sparse, may be unclear, and, when correct, reiterates text language; the writing includes some grammar and spelling errors.
1	Project solution demonstrates some knowledge of the upper level course concepts, and the solution contains conceptual and computation errors. The explanation is very incomplete, is unclear, and may be incorrect even when reiterating from the text; the writing includes grammar and spelling errors.
0	Project solution demonstrates little knowledge of the upper level course concepts and contains many conceptual and computation errors. The explanation is missing or minimal, is unclear, and is incorrect even when reiterating from the text; the writing includes major grammar and spelling errors.

Proof Rubric

4	The proof is complete and correct. It demonstrates excellent command of basic proof techniques, including application of definitions and symbolic logic. The writing is clear and demonstrates excellent standard English and mathematical notation.
3	The proof is mostly complete and correct. It demonstrates good command of basic proof techniques, and generally applies definitions and symbolic logic correctly. The writing is clear and demonstrates good standard English with at most minor grammatical errors.
2	The proof is partially correct, which may be due to incompleteness or flawed logic. It demonstrates a fair command of basic proof techniques, and often applies definitions and symbolic logic correctly. The writing includes some grammar and spelling errors.
1	The proof is generally incorrect, which may be due to an incorrect method or a correct method applied incorrectly. It demonstrates a limited grasp of basic proof techniques, and a weak understanding of definitions and symbolic logic. The writing includes grammar and spelling errors.
0	The proof is substantially incorrect. It demonstrates an unacceptable grasp of basic proof techniques, and unacceptable understanding of definitions and symbolic logic. The writing includes major grammar and spelling errors.

c. Data for Completers

In 2007-2008, some artifacts that students submitted were assessed under the 4-point (0 – 3) scale that was in effect when they completed the work.

Secondary Education – Mathematics Program Completers for years 2008 – 2010 on Mathematics Content Portfolio (undergraduates and RITE only)																
Years	Section 1 212, 314		Section 2 315, 324		Section 3 213, 314, 315, 324		Section 4 418, 431, 432, 436, 441, 458		Section 5 300		Section 6 Performance		Essay		Overall	
	#	score	#	score	#	score	#	score	#	score	#	score	#	score	#	score
2007- 2008 n = 14*	4 2 5	2/3 2.5/3 3/3	1 5 8	2/3 3/3 4/4	1 3 1 9	2/3 3/3 3/4 4/4	1 2 3 1 2 5	0/3** 2/3 3/3 2/4 3/4 4/4	1 1 1 0 2 9	0/3** 2/3 3/3 2/4 3/4 4/4	2 14***	3 4	11 3	3 4	11 3	3 4
2008- 2009 n = 6*	1 4	3 4	1 2 3	2 3 4	2 4	3 4	3 3	3 4	1 5	2 4	5 1	3 4	2 4	3 4	2 4	3 4
2009- 2010	1 5	0 3	2 5	3 4	1 2	0 3	1 7	3 4	8	4	1 5	2 3	2 6	3 4	6 2	3 4

n = 8	2 4		5 4			2 4		

* There are missing scores are due to transfer of Calculus sequence into the program.

**Score of 0 indicates portfolio entry was not submitted.

*** Two students were enrolled in the R.I.T.E. program; they were required to complete only the Performance Task.