

VIRGINIA COMMONWEALTH UNIVERSITY'S PROGRAM FOR K-6 AND 6-8 TEACHERS: THE INTERDISCIPLINARY B.S. IN SCIENCE

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Virginia Commonwealth University (VCU) has very recently revised its requirements for the K-6 Certification to include a total of 21 hours in mathematics and science as well as a three credit hour methods course in mathematics and science. This requirement includes a physical science and a biological science course, each with a laboratory component, a contemporary mathematics course with extensive student projects, collaborative work and applications, a statistics course and interdisciplinary science and mathematics course. We believe that as students complete these requirements they will meet the new State K-6 licensure requirements in all areas, with the exception of geometry. We are developing a new geometry course that we hope will be required of all future teachers.

The challenge of preparing middle school teachers to teach mathematics and/or science is much more difficult. VCU has been preparing very few middle school teachers of mathematics and science. We typically averaged less than one middle school science teacher and less than one middle school mathematics teacher per year. This paper provides a description of our interdisciplinary degree in mathematics and science that appears to be attracting significant numbers of students with an interest in teaching mathematics and/or science at the middle school level.

For the past several years, mathematics and science faculty at Virginia Commonwealth University (VCU) have worked along with teacher education faculty to align the mathematics and science requirements in the teacher preparation program with the expected increases in teacher licensure requirements. We do not believe that the resulting hours now required for our students preparing to teach in grades K-6 are disjoint from the competencies which have been established by the Virginia Board of Education. The new requirements emerged from an agreement between the disciplinary faculty and the teacher education faculty that while increased preparation standards needed to be established for the future teachers who are being trained in our program, the courses developed and pedagogy employed to achieve these standards could not be just “more of the same” course work typically delivered in lecture format. From this understanding, VCU has very recently revised its requirements for the K-6 certification to include a total of 21 semester hours in mathematics and science and a three-credit hour course in each of mathematics and science. This requirement includes a physical

science course and a biological science course, each with a laboratory component. Also required are a statistics course and a contemporary mathematics course with extensive student projects, collaborative work, and applications. An interdisciplinary science and mathematics course rounds out the 21 credits.

Nearly all of the course options available to students in this program were developed under a grant to VCEPT, the Virginia Collaborative for Excellence in the Preparation of Teachers, though the Division of Undergraduate Education at the National Science Foundation. All of these courses feature participatory, hands-on, discovery oriented learning. For example, the CBL explorations in the precalculus course require that physical phenomena graphed by the CBL from experimental data collected be modeled by mathematical equations determined by the student [1]. Students discover the exponential functions which model according to Newton's Law the heat gain or loss of a probe; they find the parabolic functions which model the distance from an origin point of a ball when rolled up a ramp; and they develop the sine or cosine function which models the distance of a swinging ball (pendulum) from its point at rest. These courses were developed or refined by teams of college faculty and practicing teachers and were pilot tested in team teaching efforts involving faculty from several VCEPT institutions. Joining Virginia Commonwealth University, lead VCEPT institution, are partner institutions: Longwood College, Mary Washington College, Norfolk State University, College of William and Mary, Virginia Union University, University of Virginia, the Mathematics and Science Center, along with J. Sargeant Reynolds, Germanna, and Tidewater Community Colleges.

One student option for an interdisciplinary science and mathematics course is the "Experiencing Science" course developed in conjunction with the Science Museum of Virginia [2]. This course is taught by a team of faculty from the Science Museum of Virginia, J. Sargeant Reynolds Community College, and Virginia Commonwealth University and is offered at the Science Museum taking advantage of the exhibits and experimental apparatus featured at that location.

Under the leadership of Dr. Loren Pitt at the University of Virginia, with VCEPT support, we are developing a new applied geometry course which we hope will be required of all future teachers [3]. We believe that as students complete these requirements they will meet the new

Virginia K-6 licensure requirements and all mathematics and science competency areas. The Elementary Education Mathematics and Science preparation requirements are recapped as follows:

ELEMENTARY EDUCATION
Preparation to Teach Mathematics and Sciences

Requirements

Mathematics and Statistical Reasoning	6 credits
Natural Sciences	12 credits
Interdisciplinary Mathematics and Science	3 credits
Teaching Mathematics and Sciences	6 credits
Recommended Additional Geometry Course	3 credits

The challenge of preparing middle school teachers to teach mathematics and/or science is much more difficult. Virginia Commonwealth University has been preparing very few middle school teachers of mathematics and science. We typically averaged less than one middle school science teacher and one middle school mathematics teacher per year. We have recently developed an interdisciplinary degree in mathematics and science that is beginning to attract significant numbers of students with an interest in teaching mathematics and/or science at the middle school level. The focus of the B.S. in Science Degree program is interdisciplinary breadth in mathematics and science training without targeting theoretical senior level/graduate level discipline courses which are structured as preparation for M.S. degree programs in the discipline. The program features strong course work extending through a calculus course, a modeling course, and a linear algebra course in mathematics and courses such as Oceanography, Meteorology and Climatology, and Ecology in Science. In the Linear Algebra course, students learn the theory of matrices and the application of matrices to solving systems of linear equations. Although not required at the most advanced levels, mastery of these skills is required in the Virginia Algebra II Standards of Learning [4]. We believe that the B.S. in Science program is particularly appropriate for future middle school teachers of mathematics and science and can also be attractive for elementary teachers who would be prepared to assume math and science leadership roles such as lead teacher positions. Currently, VCU has about ten Mathematics Track and six Science Track majors

in the B.S. in Science Program. Some National Science Foundation scholarships and other scholarships offered through the Dean of Humanities and Sciences and the Dean of Education, support the program the outline of which is given below.

Virginia Commonwealth University
B.S. in Science Program

Core Courses for Mathematics or General Science Tracks	Credits
BIO 101 (Life Science), OR BIO 102 (Science of Heredity), OR BIO 103 (Environmental Science), OR BIO 151 (Intro to Biological Science),with labs	4-5
CHEM 101 (General Chemistry), OR CHEM 110 (Chemistry and Society), with labs	4-5
PHY 101, L101 (Foundations of Physics), OR PHY 107 (Wonders of Technology), OR PHY 201 (General Physics), with lab OR PHY 207 (University Physics), with lab	4-5
GEO 203 (Physical Geography), OR GEO 204 (Physical Geography), with labs	4
SCI 300 (Experiencing Science, Science Museum of Virginia)	3
SCI 301 (Interdisciplinary Math and Science)	3
MATH 151 (Pre-calculus)	4
MATH 200 (Calculus I)	4
STAT 208 (Statistical Thinking), OR STAT 210 (Basic Practice of Statistics)	3
	33-37

General Sciences Track	Credits
BIO 315/ENS 314 (Man and Environment), OR BIO 332/ENS 330 (Environmental Pollution), OR BIO 317 (Ecology)	3
ENS/GEO 401 (Meteorology and Climatology)	3
ENS/GEO 411 (Oceanography)	3
PHY 103 and L103 (Astronomy)	4
PHY 105 and L105 (Physical Geology)	4
Second sequence of Introductory Biology, Physics, and Chemistry courses with laboratories	12-15
Two additional courses at the 200 level or higher in mathematics, science, teaching mathematics and/or science with advisor's approval	6
	35-38
Mathematics Track	Credits
CSC 128 (Computer Concepts and Applications), OR CSC 255 (Structured Programming), OR CSC 554 (Applications of Computers in Teaching Mathematics)	3
MAT 131 (Contemporary Mathematics)	3
MAT 211 (Mathematical Structures)	3
MAT 303 (Geometry)	3
MAT 310 (Linear Algebra)	3
MAT 327 (Mathematical Modeling)	3
MAT 351 (Applied Abstract Algebra)	3
Two additional courses at the 200 level or higher in mathematics, science, teaching mathematics and/or sciences with advisor's approval	6
	30

A cursory look at the above listed credit requirements for the B.S. in Science Degree might give the impression that the program requires many more credit hours than traditional degrees in mathematics, biology, etc. However, a more careful analysis reveals that the total credit requirements are comparable. For example, the B.S. in Mathematical Sciences includes 41 credits hours in the major plus 16 additional credit hours in physical and life sciences. Considering that 6 credits of the 63-67 credits in the B.S. in Science, Mathematics Track, are normally taken in Education methods courses, the 57 credits for the B.S. in Mathematical Sciences matches the lower end spectrum for credits required in the B.S. in Science, Mathematics Track. The comparison between the B.S. in Science, General Sciences Track, and the B.S. in Biology is similar considering that the latter requires 40 credits in the major plus 13 additional credits in mathematics and statistics along with 8 additional credits in physics.

We are optimistic that the B.S. in Science Degree will prove to be an attractive option for students preparing to teach mathematics and/or science at the middle school level. The program has also begun to enroll some students who are preparing to teach in the elementary grades. ■

References

- [1] R. Farley and K. Wallo, "Student Discovery and Learning through Precalculus CBL Projects, *The Journal of Mathematics and Science: Collaborative Explorations* 2(1) (1999) 29-35.
- [2] D. L. Neely-Fisher and D. B. Hagan, "Experiencing Science, An Introduction to 'Real' Methods of Science for the Preservice Teacher", *The Journal of Mathematics and Science: Collaborative Explorations* 2(2) (1999) 159-163.
- [3] L. D. Pitt, "Informal Geometry in the Preparation of Teachers: A New Mathematics Course at the University of Virginia", *The Journal of Mathematics and Science: Collaborative Explorations* 2(2) (1999) 117-120.
- [4] *Standards of Learning for Virginia Public Schools*, Board of Education, Commonwealth of Virginia, Richmond, VA, 1995.