

Meeting 21st Century Quantitative and Science Literacy Needs of Appalachian Students

Summary: Science, technology, engineering, and mathematics are playing an increasingly important role in people's everyday lives, regardless of their career choices. Mounting evidence indicates that our ability to compete and innovate in a global environment depends on a population that is educated in science, technology, engineering, and mathematics (STEM) fields. Reducing the number of required credit hours in mathematics and science is counter to current peer practices as well as Appalachian State University's stated mission of emphasizing "transferable skills and preparation for professional careers." It serves neither the students we are charged to educate nor our stakeholders in government, industry, the state, and the local community.

Appalachian State University General Education Revision: Fewer Hours is Insufficient

In Spring 2005, a task force was charged with proposing a new general education structure for Appalachian students that would reflect the best practices in college education and ensure that our graduates are well-prepared for the realities of a 21st century society. This interdisciplinary task force was composed of 22 members, 17 of whom held faculty positions in the university. Based on data regarding STEM needs from Appalachian departments, other University of North Carolina and peer institutions, national bodies, and employers of ASU graduates, this group compiled specific content objectives for quantitative and science literacy. Extensive group discussion led to the conclusion that quantitative literacy objectives could not be met sufficiently in only three hours of course time; instead, four hours of college credit is necessary to achieve the minimum content requirements. Given the factors and depth of consideration that went into this decision, it would be irresponsible to vacate this requirement for non-academic reasons.

STEM Literacy in Higher Education is Necessary for Competitiveness and Innovation

Few in higher education and industry would argue that the 21st century is an era of massive data, rapidly changing technology, and cutting-edge science. Government, industry, and academia are all stakeholders in higher education, and many groups have studied this issue. There are reports from local, state and national organizations that detail concerns regarding the potential for United States global competitiveness, such as *Bringing Government, Corporations, Foundations and Educators Together to Improve STEM Education* [1] and *Rising Above the Gathering Storm* [2]. STEM literate students are noted as especially important for the health of the economy. As the White House cautioned: "The U.S. must ensure a continuous supply of highly trained STEM workers and a STEM literate population in order to maintain its global economic leadership" [3]. Mary Ann Rankin, President and CEO of the National Math and Science Initiative, explained the issue quite well when she said: "STEM is the oxygen we need to keep moving America forward. Our country simply must educate a more STEM-literate population to remain competitive" [4].

Other groups and individuals have focused on the importance of STEM literacy for *every* student in higher education, not just those intending to enter STEM professions. Mathematician Lynn Steen emphasized the value of quantitative literacy at the college level because of "the increasing importance of quantitative data for each person's quality of life and for our collective well-being... for everyday issues of personal welfare, social decision-making, and the functioning of democratic society" [5]. In 2011, the Georgetown Center on Education and the Workforce examined 965 occupations, including many that are considered to be outside STEM [6]. Lorelle Espinosa, Director of Policy and Strategic Initiatives at the Institute for Higher Education Policy, summarized the conclusions:

Through the report, one can readily see how training in STEM aligns with other abilities that also are in demand in and out of STEM jobs—abilities like deductive reasoning, mathematical reasoning and problem sensitivity—those “problem solving” and “analytical skills” that employers are increasingly criticizing our nation’s higher education system for not providing its graduates. The STEM authors also point to the non-cognitive competencies associated with STEM occupations, including realistic and investigative “work interests” and the STEM work values of achievement, independence and recognition. [7]

Closer to home, a “Major Finding” of the University of North Carolina (UNC) Tomorrow commission was that “UNC should educate its students to be personally and professionally successful in the 21st century and, to do so, should enhance the global competitiveness of its institutions and their graduates” [8]. In recommendation 4.3.2, STEM is specifically highlighted in the context of the shortage of STEM teachers, especially in rural areas [8]. Even more locally, the town of Boone’s “Boone 2030 plan, which was adopted in 2009, includes goals for economic diversification by attracting health, technology and knowledge-based industries to the Boone area” [9]. An August 2012 *Watauga Democrat* article cited as assets in this effort “an educated workforce and the resources of Appalachian State University” [10]. To meet these calls to improve the workforce Appalachian should *increase* STEM requirements.

Peer Institution and Community Colleges Requirements Exceed Appalachian’s

The sole rationale currently offered by the General Education Advisory Group for reducing Appalachian’s mathematics and quantitative literacy (QL) requirements is to relieve transfer students who enter with 3 semester credit hours (SCH) from having to complete coursework for the necessary fourth credit. While it is true that many institutions offer 3 SCH general education mathematics courses, there is ample evidence that this is not the dominant model. For instance:

- The mean QL requirement for 37 peer institutions is 4.125 SCH [11].
- The North Carolina Community College (NCCCS) General Education Core, approved via the Articulation Agreement to fulfill *all* UNC institutions’ core requirements, specifies 6 SCH *minimum* of mathematics — 3 SCH of MAT courses and an additional 3 SCH of QL courses [12], which already exceeds Appalachian’s current requirement.
- Other UNC schools, such as UNCW, have the same QL requirement as NCCCS.
- A similar case can easily be made for science. The NCCCS General Education Core specifies 8 SHC *minimum* of natural science, further requiring a minimum of a two-course science sequence [13].

To draw comparisons nationally, the California Community College System (CACCS) and Articulation Agreement have the following requirements: 3 units of mathematics and 9 units minimum of “Scientific Inquiry and Quantitative Reasoning,” plus 7-9 units of “Physical and Biological Sciences,” for a total STEM requirement of 19-21 units. For the transferable “Liberal Arts A.A. degree,” the CACCS requires “a minimum of 18 units” with a specification of “at least one *course* [not SCH] in math” [14]. *Thus, a reduction from four to three QL hours in the requirements would mean that Appalachian would fall even further behind in STEM literacy with weaker core requirements than community college systems.*

Philosophically and functionally, the goal of general education in higher education is not to facilitate student transfer by minimizing requirements, but to “develop intellectual skills that will enhance your professional, civic, and personal life for years to come. You will learn how to analyze the world around you from different perspectives” [15]. As a university, we should be a leader in STEM education [16] and strive to devise streamlined procedures that meet our students’ financial and time needs without sacrificing necessary educational rigor and compromising our stated mission as a university.

References

- [1] The National Math + Science Initiative. (2007). *Bringing Government, Corporations, Foundations and Educators Together to Improve STEM Education*. <http://www.nationalmathandscience.org/>
- [2] National Academy of Sciences Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. (2007). *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. http://books.nap.edu/catalog.php?record_id=11463
- [3] American Competitiveness Initiative. (2006). *American Competitiveness Initiative: Leading the World in Innovation*. <http://www.innovationtaskforce.org/docs/ACI%20booklet.pdf>
- [4] National Math + Science Initiative (2012). *NMSI CEO Challenges STEM Summit to Make Teacher Training An Urgent Priority for the U.S.* <http://www.nationalmathandscience.org/newsroom/press-releases/nmsi-ceo-challenges-stem-summit-make-teacher-training-urgent-priority-us>
- [5] Steen, L. (2004). *Achieving Quantitative Literacy: An Urgent Challenge for Higher Education*. Washington, DC: The Mathematical Association of America.
- [6] Carnevale, A., Smith, N., and Melton, M. (2011). *STEM: Science, Technology, Engineering, Mathematics*. Georgetown Center on Education and the Workforce, Georgetown Public Policy Institute. <http://cew.georgetown.edu/STEM/>
- [7] Espinosa, L. (2011). *STEM Literacy Beyond STEM Occupations*. <http://diversetest.com/blogpost/369/stem-literacy-beyond-stem-occupations.html>
- [8] University of North Carolina Tomorrow Commission (2008). *UNC Tomorrow Final Report*. http://www.northcarolina.edu/nctomorrow/reports/commission/Final_Report.pdf
- [9] Town of Boone, NC, and The Lawrence Group. (2009). *Boone 2030*. <http://boone2030.blogspot.com/>
- [10] Oakes, A. (2012, 17 Aug). Area counties share business assets, deficiencies. *Watauga Democrat*. <http://www2.wataugademocrat.com/News/story/Area-counties-share-business-assets-deficiencies-id-008755>
- [11] Western Carolina University General Education Task Force (2012). *Report of the General Education Task Force: A Proposal for Change*. http://www.wcu.edu/WebFiles/PDFs/Fac_Sen_Report_of_the_General_Education_Task_Force_final_4-9-12.pdf
- [12] NC Community Colleges. (2012). *Arts and Sciences Curriculum Standards*. http://www.nccommunitycolleges.edu/Programs/curr_standard_10_arts_science.htm
- [13] NC Community College. (2007). *Mathematics (A1040E) Associate in Science Pre-Major*. http://www.nccommunitycolleges.edu/Programs/docs/CollegeTransfer/AS_Standards/118%20Math%20pre.pdf
- [14] West Valley College 2010-2011 Catalogue. (2010). West Valley College: http://www.westvalley.edu/documents/catalog/2010-2011_WVC_Catalog.pdf
- [15] Appalachian State University. (2012). *General Education Program*. <http://generaleducation.appstate.edu>
- [16] Sanders, T. (2004). *No Time to Waste: The Vital Role of College and University Leaders in Improving Science and Mathematics Education*. United States Department of Education. <http://www.ecs.org/html/Document.asp?chouseid=5480>