
7-1-2021

STEM Education Within the West Point Experience

Carolann Koleci

United States Military Academy, carolann.koleci@westpoint.edu

Eileen Kowalski

United States Military Academy, eileen.kowalski@westpoint.edu

Kenneth McDonald

United States Military Academy, kenneth.mcdonald2@westpoint.edu



Recommended Citation

Koleci, C., Kowalski, E., & McDonald, K. (2021). STEM Education Within the West Point Experience. *Journal of College Science Teaching*, 50(6). <https://www.nsta.org/journal-college-science-teaching/journal-college-science-teaching-julyaugust-2021/stem-education>

STEM Education Within the West Point Experience

By Carolann Koleci, Eileen Kowalski, and Kenneth McDonald

At conferences or meetings, West Point faculty are often asked, “What’s it like to teach at West Point?” To answer this question we present the unique model that West Point uses to bridge traditional higher education and the United States Army. The West Point model stems from its mission to develop cadets as leaders of character who are prepared to be the future leaders of the U.S. Army. To fulfill the mission, cadets meet physical and military requirements, in addition to earning a Bachelor of Science degree. Here we discuss how the West Point student body, curriculum, and mission affect courses and opportunities in STEM.

“What is it like to teach at West Point?” The earliest literature to address this question dates back to 1944 with a description of the setting, physics curriculum, students, and other factors at the United States Military Academy at West Point, often referred to as West Point (Bartlett, 1944). Since this publication, several reports have come out describing the different classroom teaching techniques, major specific curricula, and departmental structures at West Point (McGinnis, 2004; Owens, 1995; Owens & Springer, 1996; Rabb & Klegka, 2001). Others have also published works describing education at other service academies and in Reserve Officers’ Training Corps (ROTC) (Ogle & Winslow, 1953; Madden, 1957; O’Reilly, 2007). However, education at West Point has changed in the past 75 years; this article offers a more up-to-date review of education at West Point, within the context of the student body, curriculum, and mission of the academy.

Founded in 1802 as an engineering school, West Point is the oldest of the five U.S. federal service academies that also include the Naval, Air Force, Coast Guard, and Merchant Marine academies. West Point is a public institution located 50 miles north of New York City along the Hudson River and has a total undergraduate enrollment of 4,400.

Unlike civilian colleges and universities, students at West Point are referred to as cadets; they are officers in training, who have the ultimate goal

to graduate from West Point and commission as officers in the U.S. Army. While at West Point, cadets’ tuition is fully funded by the U.S. Army in exchange for at least five years of active duty service once they commission.

West Point strives to make the Corps of Cadets mirror the active Army. Within the Corps of Cadets, 95% hail from all 50 states and U.S. territories, with the remaining 5% from countries around the world. In addition to a diverse geographical representation, West Point considers several other attributes. For example, in 2018, 26.8% of the total Corps of Cadets were recruited athletes. Of the 1,200 cadets admitted, a majority came from high school while 200 came from the United States Military Preparatory School (M. Wong-Dodge, personal communication, December 4, 2018) and an additional 10 were combat veterans (USMA, 2019b).

The mission of West Point is to build agile and adaptive leaders of character. To accomplish the mission, the superintendent of West Point, a lieutenant general in the Army and the equivalent of a college president, ensures that the cadets are held to rigorous academic, military, and physical standards. The educational standards at West Point are equivalent to that of other accredited undergraduate institutions, while the military standards require cadets to critically analyze, execute, and assess various scenarios they are likely to encounter in the operational Army.

The Corps of Cadets and their military training mentors and instructors are commanded by the commandant

of cadets who is a brigadier general in the U.S. Army. Within the Corps, the cadets are assembled into a chain of command with the most experienced cadets given positions of increasing responsibility. This chain of command affords cadets several opportunities to practice and develop leadership skills with their peers before the cadets become officers.

The academic development of the cadets is overseen by the dean who is also a brigadier general in the U.S. Army. At West Point, approximately 75% of faculty are military officers with the remainder comprised of roughly 100 civilian faculty. Among civilian and military faculty, about 30% hold doctoral degrees and all other faculty hold master's degrees (USMA, 2018).

The 47-month experience

New cadets arrive at West Point on Reception Day, six weeks preceding their first academic year, and graduate 47 months later if they have fulfilled all the graduation requirements. On Reception Day, new cadets are immediately placed into Cadet Basic Training (CBT) where they develop basic soldier skills, discipline, sound decorum, and physical fitness. CBT is an intense experience that tests a cadet's equanimity, perseverance, and ability to lead under intense pressure and circumstances. Once new cadets have completed CBT, they are accepted into the Corps of Cadets and given a sophomore sponsor to help them transition into life during the academic year at West Point.

A typical class day for cadets can begin after 5:20 a.m. when they are allowed to leave their barracks. Some cadets will wake up at this time to do physical training (PT) while some may use this time to do academic work. Others will sleep until their first duty of the day, which is breakfast formation at 6:50 a.m. Morning classes begin at 7:30 a.m. and continue until

the cadets report for lunch formation at 11:50 a.m. Classes are on a rotating schedule, termed "Day 1" and "Day 2," and cadets have courses assigned to each of these schedule blocks. After lunch on Day 1s, the 12:35 to 1:50 p.m. period rotates between academic time ("Dean's Hour") and military training time ("Commandant's Hour"). During this time, cadets may attend mandatory briefings or scheduled trainings. After Dean's Hour or Commandants' Hour, cadets attend afternoon classes. After lunch on Day 2s, cadets immediately proceed to afternoon classes or labs. During open periods cadets can seek help from instructors.

When the last class ends at 4:00 p.m. all cadets participate in an athletic activity, ranging from intramurals and club sports to intercollegiate squad activities (NCAA sports). This period typically runs to 6:00 p.m., after which cadets are free to eat dinner until 7:30 p.m. The dinner period transitions into Evening Study Period (ESP), which is the designated study time from 7:30 to 11:30 p.m. The end of a cadet day is marked by the playing of Taps at 11:30 p.m. (USMA, personal communication, May 4, 2016). A typical day of a cadet is summarized in Table 1.

In a given week, cadets typically have four or five days of classes, rotating duties on Saturday mornings, and Sundays free from duties. Similar to Dean's and Commandant's Hours, Saturday mornings can be assigned different tasks such as room inspections, military training, study time, make-up exams, mandatory attendance at home football games, or free time. Once a cadet's Saturday obligations have been met, they have the rest of the weekend off. This weekly schedule continues until the end of the academic year except during final exams, Thanksgiving, winter break, and spring break.

During the semester, a typical course load is six courses. The courses are scheduled to be either on a Day 1 or Day 2 with 30 to 40 meetings for the semester, depending on the course's assigned credit hours and the length of the class meetings (55 to 140 minutes). Once cadets have taken their last final exam, they are free from duties until Reorganization Week before the beginning of the spring semester. Upon completion of the spring semester, cadets remain for Graduation Week while seniors fulfill their last duties at West Point and all other cadets attend their fellow cadets' graduation.

TABLE 1

Typical day of a cadet.

Time	Daily activity
5:20 a.m.	Wake up
6:50–7:20 a.m.	Breakfast formation
7:30–11:40 a.m.	Morning classes
11:50 a.m.–12:25 p.m.	Lunch formation
12:35–1:50 p.m.	Dean's/Commandant's Hour (Day 1) or afternoon classes (Day 2)
2:00–4:00 p.m.	Afternoon classes
4:10–6:10 p.m.	Intramurals, club sports, squad activities, etc.
6:00–7:30 p.m.	Dinner
7:30–11:30 p.m.	Evening study period
11:30 p.m.	Taps (lights out)

In addition to meeting the academic standards of West Point throughout the year, cadets are also expected to meet the Army's standards for physical fitness measured by the bi-annual Army Combat Fitness Test (ACFT). For the ACFT, cadets must complete a required number of exercises (for example, deadlifts, leg tucks, and push-ups) and complete a two-mile run in a specific amount of time (Army Training and Doctrine Command, 2020). Second-year and third-year cadets also complete the Indoor Obstacle Course Test (IOCT) which is a time-stressed, acrobatic, and aerobic challenge designed to test the cadets' physical performance under extreme conditions.

After the academic year ends, cadets may take classes over the summer, known as Summer Term

Academic Program (STAP). Cadets may volunteer to take a STAP class, or they may have an academic deficiency through failing a class that could lead to missing graduation at the end of 47 months. STAP classes have the full content and assignments of a normal semester condensed into three or four weeks.

Cadets also complete military in-field training before the end of the summer. Cadets starting their second year at the academy typically spend three or four weeks of their summer undergoing Cadet Field Training (CFT) at Camp Buckner, part of the West Point Military reservation. CFT comprises rigorous training in general military skills, individual readiness, and long-term small unit field operations (USMA, 2019c). Junior and senior cadets, respectively, are

required to complete Cadet Leadership Development Training (CLDT) and Cadet Troop Leader Training (CTLT) before they graduate. CLDT focuses on training cadets on how to lead troops, effectively communicate, and make tactical decisions within a small unit (USMA, 2019c). During CTLT, cadets shadow lieutenants at another Army unit, giving the cadets an understanding of what they can expect and what is expected of them once they graduate and commission (USMA, 2019c).

In addition to mandatory military training, cadets can participate in specialty military training known as Military Individual Advanced Development (MIAD). MIAD opportunities can include combat diving, mountain warfare, air assault (repelling from a helicopter), airborne (parachuting), sapper leader (combat engineering), etc. These trainings give cadets perspective and context with how the Army trains soldiers and leaders in the field as well as providing cadets a great confidence-building experience before they are commissioned into the Army (USMA, personal communication, June 10, 2020).

If there is time available in a cadet's summer schedule and they are willing to forgo some leave, they can participate in an Academic Individual Advanced Development (AIAD). AIADs are analogous to a summer research experience for undergraduates that are offered at other schools. For an AIAD, cadets typically spend three or four weeks at a location related to their chosen major and immerse themselves in an educational experience that would not be possible within the usual framework of West Point (USMA, 2019a).

Throughout the cadets' 47-month experience at West Point their academic, military, and physical performance is graded and used to determine their class rank. Class rank factors into cadets' assignment of branch in the Army, which is received during

FIGURE 1

Overview of the academic program: Class of 2019 and beyond. Courses in blue are math, science and engineering (MSE) courses. Curricular components are described in section IV (USMA, 2019a).

Core: 1 Chemistry 1 2 Physics 1 3 Chemistry 2, Physics 2, or Biology 4 Math (Modeling) 5 Math (Calculus) 6 Math (Statistics) 7 IT, Computing, and Cyber 1 8 Cyber 2, Science, or Math 9 Physical Geography 10 History 1 (U.S.) 11 Composition 12 Literature 13 Philosophy & Ethical Reasoning 14 Psychology 15 Economics 16 Political Science 17 International Relations	Engineering Sequence (3 Courses) 25 Engineering Sequence Course 1 26 Engineering Sequence Course 2 27 Engineering Sequence Course 3
Core Culture/Region Thread: 18 Foreign Language 1 19 Foreign Language 2 20 History 2 (Region) 21 History 3 (Military) 22 Leadership 23 Law 24 Officership	Major (10 Courses) 28 Major Course 1 29 Major Course 2 30 Major Course 3 31 Major Course 4 32 Major Course 5 33 Major Course 6 34 Major Course 7 35 Major Course 8 36 Major Course 9 37 Major Course 10 – Integrative Experience
	Complementary Support (3 Courses) 38 Complementary Support Course 1 39 Complementary Support Course 2 40 Complementary Support Course 3
	Other Required Courses 3 x Military Science (total 4.5 Credit Hours) - Intro to Warfighting - Fund of Small Unit Operations - Platoon Operations 7 x Physical Education (total 5.5 Credit Hours)

the fall semester of their senior year. Class rank also determines the order in which cadets choose their first duty station (location of assignment) after graduation. With limited availability for new officers in each branch and at each duty station, the cadets place a tremendous amount of importance on class rank.

At the end of the 47-month experience, seniors graduate, are commissioned as second lieutenants in the Army and take leave for up to 90 days. Then, they move on to their new assignments.

Challenges and opportunities

Because West Point prepares graduates to be commissioned Army officers, cadets have a highly regiment-

ed schedule that includes academic, athletic, and military requirements and activities. Although cadets' attendance at classes is mandatory, many exceptions are granted for cadets, especially when they have opportunities that require them to travel away from the Academy. For example, cadets working on capstone (senior engineering project), research, or independent projects might visit schools, government labs, or companies where their collaborators work. Division I cadet-athletes travel to competitions. Cadets participating in conferences on Leadership or Honorable Living might also miss classes or military training. While each of these are valid reasons to travel, traveling requires make-ups for classes, labs, and exams. Finding time for

these make-up events in an already busy schedule becomes a challenging puzzle for cadets and faculty.

As is typical of students at many institutions, cadets often struggle with time management. Because cadets wear ironed uniforms and shined shoes, their appearance is organized and professional. This can be deceiving; on the inside cadets have the same confusion and uncertainty as many students at other colleges and universities. Not all cadets will reveal their confusion to faculty and ask for help. Some of them do not want to take faculty away from other work. They may feel their questions are not worth faculty time. Other cadets do not realize that it's typical for students to work with faculty during office hours. Similar to students at other

FIGURE 2

Typical sequence of courses—eight term academic program (8TAP)—class of 2019 and beyond. Physical education and military science courses are not shown (USMA, 2019a).

1st Year		2nd Year		3rd Year		4th Year	
Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
English Composition	English Literature	Major Course 1	Major Course 2	Major Course 3	Major Course 4	Major Course 5	Major Course 6
Chemistry 1 OR Geography	Physics 1 OR Chemistry 1	Science 2 OR Physics 1	Geography OR Science 2	Major Course 7	Major Course 8	Major Course 9	Major Course 10
Math Modeling	Calculus	Philosophy OR Probability/ Statistics	Probability/ Statistics OR Philosophy	CES Course 1	CES Course 2	CES Course 3	Major CSC 2
Information Technology OR Psychology	Psychology OR Information Technology	Political Science OR Economics	Economics OR Political Science	Leadership OR IR ¹	IR ¹ OR Leadership	Major CSC 1	Major CSC 3
Am. History OR Reg. History	Reg. History OR Am. History	Language 1	Language 2	Mil. Art ³ OR IT/Cyber ²	IT/Cyber ² OR Mil. Art ³	MX400 ⁴ OR Law	Law OR MX400 ⁴
Must select major midway of first year		Yellow shaded cells = Slots to schedule courses in each major including Complementary Support Courses (CSC)		CES = Core Engineering Sequence IR ¹ = International Relations Am. History = American History Reg. History = Regional History		IT/Cyber ² = Information/ Cyber Technology Mil. Art ³ = History of Military Art MX400 ⁴ = Officership	
Credits, With Military Science/Physical Education Balanced							
17.5 - 18.5	19	18.5	18 - 19	16+	16.5+	16.5+	15+

schools, cadets need time to transition from a high school to a college mindset.

A challenge not necessarily present at other schools is the Academy's culture of "cooperate to graduate." This culture can be helpful in forming cohesive units and lifelong friendships. Cadets are usually willing to help each other, such as checking each other's uniforms or showing one another how they approached a calculation. The challenge comes when cadets only rely on each other, without reaching out to faculty or accessing other resources that West Point has created to help cadets with time management, study skills, and test anxiety.

Relationships are not short-lived at West Point and build over four years and beyond. Very much like the culture of the Army, the Corps of Cadets is committed to people. To help the cadets understand this, they are given a faculty sponsor once they arrive at West Point. Sponsors are like a cadet's home-away-from-home family in that cadets are often invited by their sponsor family for dinner or lunch. During times of celebration, sponsors often offer gifts or bake desserts. In times of need, sponsors are also there to listen, offer advice or constructive criticism, and even offer their washer and dryer for emergency laundry runs. West Point is a family-oriented community that prides itself on honorable living, character, and values.

STEM in the curriculum

Within the unique social and cultural structure that comprises West Point, cadets who graduate must successfully complete 40 academic courses, plus three military science courses and seven physical education courses. Of the 40 academic courses, 13 courses depend on the cadets' major and 27 are required of all cadets. Twelve of these 27 required courses are STEM courses (see Figure 1). All cadets, no matter what they choose as their major, take one semester of

general chemistry, one semester of physics, and three semesters of math (modeling, calculus, and statistics). Cadets also take two semesters of information technology and a three-course engineering sequence. A semester of physical geology and the cadet's choice of general chemistry 2, physics 2, or biology round out the 12 required STEM courses.

The overall goal of the STEM curriculum at West Point is to ensure that cadets who graduate can apply STEM concepts and processes to solve complex problems. To achieve this overall goal, the STEM curriculum has been designed with five sub goals in mind (USMA, 2019a):

1. Apply mathematics, science, and computing to model devices, systems, processes, or behaviors.
2. Apply the scientific method.
3. Collect and analyze data in support of decision making.
4. Apply an engineering design process to create effective and adaptable solutions.
5. Explain and apply computing and information technology concepts and practices in the context of the cyber domain.

The nine STEM courses that are part of the core curriculum (see Figure 1) were chosen to meet sub goals 1, 2, 3, and 5. Sub goal 4 is met by the introduction of the three-course engineering sequence from which each cadet can choose one. There are six different engineering sequences: Infrastructure Engineering, Cyber Engineering, Robotics Engineering, Environmental Engineering, Nuclear Engineering, and Systems Engineering (USMA, 2019a).

Cadets may get credit for a course if they have taken the course at another college or they can demonstrate acceptable knowledge of the material. Copies of transcripts, course syllabi, advanced placement scores, and scores on a placement exam may all

be used to identify cadets who validate required courses. About 5% of cadets typically validate introductory STEM courses.

Summary

What is it like to teach at West Point? With its unique blend of higher education and the U.S. Army, West Point is a cohesive and intense community that holds both cadets and faculty to the same ideals.

The student body is unique with diversity in demographics and college experience. While the cadets are certainly not immune to many of the challenges typical college students face, cadets have additional challenges that make time management essential to successfully navigate their 47-month experience. In addition to daily academic responsibilities, cadets at West Point undergo rigorous military and physical fitness training. With this regard, West Point accomplishes its mission to develop agile and adaptive leaders of character.

Along the way, West Point's curriculum has a solid STEM foundation that builds scientific and engineering literacy in its graduates. Further answers to the question "What is it like to teach at West Point?" will be answered in subsequent work, with a focus on the STEM faculty and the classroom.

Acknowledgments

The authors thank Ms. Laura Mosher for her assistance with literature searches, and we appreciate Dr. Colleen McDonald for her helpful comments and careful proofreading of a draft of this work. The views expressed herein are those of the authors and do not purport to reflect the position of the United States Military Academy, the Department of the Army, or the Department of Defense.

References

Army Training and Doctrine Command. (2020). The Army combat fitness test. <https://usacac.army.mil/sites/>

- default/files/publications/18-37.pdf
- Bartlett, B. W. (1944). Physics at the United States Military Academy. *American Journal of Physics*, 12(4), 78–91.
- Madden, R. B. (1957). The undergraduate education of naval engineers—U. S. Naval Academy. *Journal of the American Society of Naval Engineers*, 69(1), 7–28.
- McGinnis, M. L. (2004). Technical report. Transforming the department: 1999–2004. Department of Systems Engineering. <https://bit.ly/3yIYjww>
- O'Reilly, M. T. (2007). *An exploratory study of the United States Naval Academy engineering curriculum* (Master's thesis). The Naval Postgraduate School, Monterey, CA. <https://calhoun.nps.edu/handle/10945/3401>
- Ogle, M. F. & Winslow, D. C. (1953). A generalized educational program for the US AFROTC. *The Phi Beta Kappan*, 34(4), 149–153.
- Owens, P. M. (1995). A general chemistry course that focuses on the emerging chemical sciences. *Journal of Chemical Education*, 72(6), 528–530.
- Owens, P. M., & Springer, D. S. (1996). Spending less time on traditional topics in general chemistry. *American Chemical Society Division of Chemical Education Fall 1996 Newsletter*, 67–69.
- Rabb, R. J., & Klegka, J. S. (2001). Designing an engineering experience for non-engineers. *Proceedings of the 2001 American Society for Engineering Education Annual Conference on Engineering Education*, Albuquerque, NM, June 24–27.
- United States Military Academy (USMA). (2018). Educating Army leaders. <https://westpoint.edu/academics/dean/strategic-documents>
- United States Military Academy (USMA). (2019a). Academic program: Curriculum and course descriptions. <https://courses.westpoint.edu/static/index.htm>
- United States Military Academy (USMA). (2019b). Admissions. <https://westpoint.edu/admissions/class-profile>
- United States Military Academy (USMA). (2019c). Cadet summer training. <https://westpoint.edu/military/department-of-military-instruction/cadet-summer-training>

Carolann Koleci (carolann.koleci@westpoint.edu) is an assistant professor in the Department of Physics and Nuclear Engineering, **Eileen Kowalski** (eileen.kowalski@westpoint.edu) is an associate professor in the Department of Chemistry and Life Science, and **Kenneth McDonald** (kenneth.mcdonald2@westpoint.edu) is an assistant professor in the Department of Civil and Mechanical Engineering, all at the United States Military Academy at West Point in West Point, New York.
