St. John's College: American Liberal Arts Education Redefined

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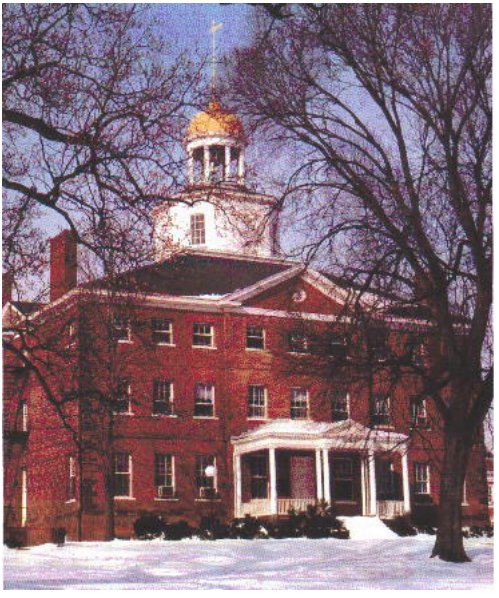
St. John's College in Sante Fe, New Mexico, USA



McDowell Hall, the central academic building of St. John's College, Annapolis, MD

St. John's College occupies a special position among American colleges and universities. Since 1937, the College's curriculum—a unified liberal arts program that offers virtually no electives and that focuses on classic texts

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in literature, philosophy, science and mathematics—has challenged some of the fundamental ideas of American higher education. Despite being now well-established, faculty and students at St. John's still occasionally refer the curriculum as "the New Program," but the titles "the St. John's Program" or simply "the Program" are more common. St. John's College is often called the "Great Books School," a label that is accurate as far as it goes but is incomplete. It identifies one aspect of the Program—the texts that make up the content of study—while bypassing other features that are equally important, such as the unity of the curriculum, the lack of specialization of the faculty, and the inclusion of science and mathematics as part of the liberal arts.

St. John's College is not an experimental school. Although some refer to any small, unusual curriculum as "experimental," the St. John's Program has been in operation for over seventy years and the College is broadly satisfied that the present form of the Program accomplishes what it sets out to do, *viz*., to introduce students to the liberal arts through active reading and discussion of great texts. St. John's College is not really an *experiment* but a *protest* against the fragmentation of undergraduate education, as well as an *essay* in showing an alternative form of teaching that introduces students to existing traditions while maintaining freedom of thought and inquiry. As explained more fully below, although the St. John's Program requires the students to read an extensive list of required texts, they are not asked to adopt the ideas put forward by any of the authors. That would hardly be possible since many of the Program authors disagree with one another. Rather, the College hopes that students will become alive to fundamental issues and questions that have shaped, and continue to shape, the world in which they live.

The St. John's Program grew from reformist theories about American higher education and can best be understood in light of the intellectual

currents that shaped its creation. Like any concrete institution, St. John's College has its own history that determines how it came about in the particular time and place where it arose. St. John's College's institutional history goes back to the 17th century in Colonial Maryland. However, the education practices of the College are grounded in ongoing, timeless debates about the best form of human education. The ideas that shape the College are not exclusively American or even Western. In recent years, Professor Gan Yang has created Boya College at Sun Yat-sen University in Guangzhou, a school that shares some of the basic principles of St. John's College, and is expanding this development of liberal arts teaching to other Chinese universities. Boya College and St. John's College (Santa Fe) have entered upon an agreement providing for exchange of students and faculty in coming years and both institutions look forward to cooperation in development of liberal arts education in China.

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St. John's College—Institutional History

St. John's College can trace its roots to the founding of King Williams School in Annapolis, Maryland in 1693.[1] Originally a secondary preparatory school, the school was merged into the newly-chartered "St. John's College" (abandoning the name of the English monarch who was no longer popular

1 It is on the basis of this date that St. John's College stakes its tenuous and ultimately unimportant claim to be the third oldest college in America, after Harvard College (1636) and the College of William and Mary (1693). The nature of the school changed so radically with the arrival of the New Program in 1937 that this claim to historical primacy means very little except to romantically inclined alumni associations.

after the American Revolution) and became a degree-granting college in 1784. Despite its name, St. John's was never a religious college: from its foundation the school admitted qualified students "without requiring or enforcing any religious or civil test." The school was originally supported by the State of Maryland, but became private in 1805. It closed briefly during the American Civil War when students were drawn away to military duty. During the War, the College's facilities were turned to use first as a barracks and later a prison camp and military hospital.

The College reopened in 1866 and gradually recovered its fortunes. For a while beginning in 1884, the College operated as a military school; that phase of the College's history ended in 1923.

The stock market crash of 1929 and the following depression severely threatened St. John's College's financial stability. By 1936, St. John's was on the edge of collapse. Rather than closing, however, the school's Board of Visitors and Governors decided to attempt a complete reformation of the school's curriculum and to begin the school's history anew.

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Origins of the New Program: C. W. Eliot, Harvard and the Elective System

The New Program at St. John's College arose from the work of scholars in the early 20th century seeking to rescue undergraduate liberal arts education from the chaos into which it had fallen. The Program was in large part a response and critique of the educational reforms begun while

Charles William Eliot was President of Harvard University (1869–1909), especially the Elective System.

American undergraduate education in the 19th century was torn by conflicting pressures, from its traditional past on the one hand and from the growing need for scientific and technical training on the other hand. In the early years of the American republic, liberal arts colleges had existed principally to train clergymen. The curriculum of these colleges consisted largely of Greek, Latin, sometimes Hebrew and a modest amount of mathematics. With the advent of industrial technology, scientific schools were founded as adjuncts to these liberal arts undergraduate colleges.[2] In addition, state governments founded schools aimed at practical and vocational education. By the mid-1800s, traditional liberal arts colleges existed side-by-side with scientific and vocational schools. In the view of Harvard President C. W. Eliot, neither offered an ideal education for American leaders. Traditional colleges provided a classical training that was parochial and had no practical value, while scientific and technical schools furnished training that was narrow, technical and stultifying.

Eliot's answer was twofold—specialization of the faculty and the Elective System for undergraduates. He joined forces with those who were already working to turn Harvard away from its attachment to the Congregationalist church and the mission of training preachers and to develop instead a top-rank faculty devoted to academic research on the model of European universities. This expanded and specialized faculty provided

2 For example, the Lawrence Scientific School at Harvard (1847); the Sheffield Scientific School at Yale (1847); the Chandler School of Science and Arts associated with Dartmouth College (1852).

a cafeteria of class offerings among which undergraduates were free to choose at they saw fit. The move toward specialization, or "the division of mental labor" as Eliot (1869) called it, was effective in increasing the academic reputation of the Harvard faculty. Other schools soon followed Harvard's lead.

It was less clear that the Elective System provided a coherent education for undergraduates. Many schools adopted some version of Harvard's Elective System for undergraduate education because it was—and still is—the natural counterpart to an academic faculty divided into separate specialized departments, but they were troubled by the lack of general supervision of undergraduate education as a whole. Concerns were expressed from the outset. Were 18-year-old students really able to compile a proper educational path for themselves from the varied and scattered offerings of university departments?[3] Critics argued that allowing students complete freedom to choose their classes would lead to a narrow and eccentrically specialized experience.[4] These concerns have persisted. Various compromises have been tried in an attempt to limit the fragmentation of undergraduate education inherent in the Elective System. Some schools require certain "core" courses of all students; some posit "distribution requirements" that direct students to take some classes in a scattered variety of fields. Student

3 Eliot himself explicitly argued that they were in an 1895 speech entitled "The Elective System." "Is it possible that the accumulated wisdom of the race cannot prescribe with certainty the studies which will best develop the human mind in general between the ages of eighteen and twenty-two? At first it certainly seems strange that we have to answer 'no' [.]" Many remained dubious.

4 A detailed description of the debate between the "liberal-free" (elective) concept of education and the *artes liberales* ideal that proposes a prescribed content for undergraduate education, see Kimball (1986), especially chap. 6. A brief review of the debate is available in Denham (2002).

choice is frequently limited to selection among pre-defined "majors" that each have their own required classes.

In the early 20th century many were dissatisfied with the chaotic and unsatisfactory state of American undergraduate education. In response to these problems, a handful of reformers including two Rhodes scholars, Stringfellow Barr (1897–1982) and Scott Buchanan (1895–1968), designed more radical responses that would ultimately lead to creation of the New Program at St. John's College.

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Buchanan, Barr and the Creation of the New Program

Scott Buchanan began thinking of the educational reforms that would lead to the New Program when he was an undergraduate at Amherst College. There he was a student of Alexander Meiklejohn, then president of Amherst, who "discouraged lecturing and encouraged teaching and learning by discussion" (Smith, 1983, p. 7). From Meiklejohn, Buchanan gained an excitement for Socratic questioning. "[I]t was through Alec Meiklejohn that the whole living Socratic method became clear. There was a time when the whole college seemed to be Socratic" (*Embers of the World*, 1969). While at Amherst, Buchanan also encountered John Erskine of Columbia University, who had for some years been "working out a number of ideas about the presentation of great authors and their works to young people, normally and properly occupied with contemporary life" (Erskine, 1948, p. 165).

Buchanan's ideas for education from Great Books developed further in his early teaching experience. After a Rhodes scholarship at Oxford,

Buchanan obtained a Ph.D. in philosophy at Harvard and taught for a year at the College of the City of New York. In 1925, he became assistant director of the People's Institute of the Cooper Union in New York, where he organized lectures aimed at interested individuals not working toward a formal academic degree. Here Buchanan experienced how discussion about classic texts such as Dante's *Divine Comedy* could generate intellectual excitement outside of ordinary academic circles.

While Buchanan was working at the People's Institute, other schools were trying "Great Books seminars" as a means to counteract the fragmentation and incoherence of undergraduate curricula. At Columbia University, Erskine was implementing a core curriculum based on the reading of a list of great works. At the University of Chicago, university president Robert M. Hutchins and Mortimer Adler were advancing similar ideas (Denham, 2002).

Buchanan continued to develop ideas for undergraduate education at the University of Virginia, where he joined the philosophy faculty in 1929. There he re-joined Stringfellow Barr, a colleague whom he knew from time shared at Oxford University. While at Virginia, Buchanan studied mathematics and logic and became convinced that a proper liberal arts education could not omit these subjects. Buchanan and Barr worked together to design a two-year long "honors program" for gifted students that would consist of "study and practice of the liberal arts through the reading and discussion of great books" (Smith, 1983, p. 17). The plan was never implemented—it was far too ambitious to be carried out in the time allowed—but it ultimately became a template for the four-year curriculum of St. John's College.

By 1937, Buchanan was anxious to try something new. It was clear that his honors curriculum would not be adopted at Virginia. Tentative plans to

try the curriculum at the University of Chicago fell through. Then, by chance, Buchanan met members of the Board of Visitors and Governors of St. John's College in Annapolis, Maryland and learned of the school's situation. The College being in desperate straits, its Board was willing to give Barr and Buchanan extraordinary freedom to implement their ideas at St. John's.

The New Program of St. John's College was born.

St. John's College, Santa Fe NM

Overcoming some early difficult years, enthusiasm for the New Program attracted students and gradually restored stability to the school. By the early 1960s, thanks to a growing student body and a gift of land from actress Greer Garson, a second campus was built in Santa Fe, New Mexico. Since 1964, St. John's has carried out an identical Program of instruction in two locations, one in the Maryland tidewater beside the Chesapeake Bay and the other in the Sangre de Cristo mountains of the American south-western desert, separated by over two thousand miles.

In 1967, the College began to offer a master's degree program in liberal arts, first in Santa Fe and later in Annapolis as well. In 1994, a new program in Eastern Classics was instituted on the Santa Fe campus.

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Principles of the St. John's Program

There are five principles that characterize the St. John's Program. They have been present in the curriculum since the New Program was instituted in 1937 and still guide the College. In brief, they are:

- *Great Books*
- *Discussion Classes*
- *Unity of the Curriculum*
- *Non-Specialization of the Faculty*
- *Inclusion of Math and Science among the Liberal Arts*

Great Books. Instruction at St. John's College takes place principally by the reading and discussion of Great Books.

The exact definition of "Great Books" is, unsurprisingly, the subject of some controversy. To begin with, a *limited*, *negative* criterion of what constitutes a Great Book is that it is *not a textbook*. That is, a Great Book is not one written by a teacher expressly for students. Textbooks are generally written with an unavoidable and even appropriate attitude of

condescension: The author knows a subject, the reader does not know it, and the book aims to convey well-digested information to the reader. Such books, once mastered, are generally set aside and rarely re-read.

Great Books, by contrast, are not tidy summaries of well-understood facts. They are often works of exploration and discovery, conveying new ideas and new ways of understanding. They are not aimed at students but at a general audience or sometimes at professional colleagues. Unlike textbooks, Great Books are usually read more than once—even again and again. It is characteristic of a Great Book that it repays each re-reading with new insights and understanding.

Whenever possible, St. John's assigns complete works to be studied. Ideally, a Great Book should speak for itself. If a Great Book is severely edited, or if portions from it are extracted and included in an anthology or offered as a supplement to a modern text, the student may find that he or she is studying the editor's or anthologizer's ideas rather than those of the Great Book author, whose text has been cut apart and made to function like tiles in a mosaic constructed by the editor.

A Great Book is one to which generations of readers have returned and found an inexhaustible source for reflection and inspiration. In the Western tradition, the dialogues of Plato—about which Alfred North Whitehead (1978, p. 39) famously remarked that all of Western Philosophy is merely a "series of footnotes"—exemplify this sort of text. Similarly, Homer's *Iliad* and *Odyssey* furnished continuing inspiration to ancient Greek and Roman civilizations and continue to move modern readers. The plays of William Shakespeare continue to challenge, enlighten and entertain audiences and

scholars over four hundred years after their original performances. The Bible, understood not as a divine text to which a worshiper's life is abjectly submitted, but as a text that successive generations have revisited for new insights and inspiration, is another ideal example of a Great Book that repays repeated re-reading.

Although the New Program at St. John's originally focused exclusively on Great Books of the Western tradition, that position has changed in the last two decades. Various arguments were offered to justify Western parochialism. Some claimed that students should learn their own traditions before examining others. Others worried that faculty lacked linguistic competence to read non-Western books or even that discussion in the St. John's manner might not be appropriate to Oriental texts which might require instead commitment to "living discipline" (Brann, 1979, p. 66). In 1994, however, the College established a post-graduate program of study in Eastern Classics on its Santa Fe campus. Since then, students in this program have read and discussed classic texts from India, China and Japan in the fashion of St. John's seminars.[5] They have studied Sanskrit and Chinese and the faculty has developed the linguistic competence whose absence had previously justified omitting these books. The undergraduate Program still focuses exclusively on Western texts largely because there is not enough time available to include more readings without losing the coherence and inter-textual conversation that the present sequence of readings allows.

With these examples in mind, an attempt might be made at a definition

5 A summary of the Eastern Classics reading list is attached as Appendix I to this article.

of a "Great Book." The original statement of the St. John's Program offered five criteria:

- **"[A] great book is one that has been read by the largest number of persons . . . ."**
- **"[A] great book has the largest number of possible interpretations.** This . . . refers to the inexhaustibility of its significance."
- **"[A] great book should raise the persistent unanswerable questions about . . . great themes . . . ."**
- **"[A] great book must be a work of fine art;** it must have an immediate intelligibility and style which will excite and discipline the ordinary mind by its form alone."
- **"[A] great book must be a masterpiece of the liberal arts.** Its author must be a master of the arts of thought and imagination whose work has been faithful to the ends of these arts, the understanding and exposition of the truth."

Speaking from personal experience, I can testify that the books of the St. John's Program merit continual re-reading. After more than twenty-five years of experience with the texts of the St. John's College, the works continue to be fresh with each reading and to bring out interesting and exciting insights in each seminar conversation. Nor are Great Books limited to particular cultural settings. My wife Martha and I spent the academic years 2012–2014 teaching at the Dalton Academy in Beijing (北大附中). Among other things, during that time we led St. John's style discussion classes for

Chinese high school students reading and discussing Shakespeare's *Hamlet* for an entire semester. Martha led another such discussion class on Herman Melville's *Moby Dick*. In each case, we found that after a brief period of accommodation, our Chinese students responded with the same enthusiasm and interest to conversations arising from these texts as had our American students at St. John's College. Conversely, experience in Santa Fe with the Eastern Classics program has confirmed that Great Books from other traditions, ranging from the *Bhagavad Gita* (भगवद्गीता) to the works of Confucius (孔子) and Mencius (孟子) and the Japanese *Tale of Genji* (源氏物語) engage Western students, reward repeated readings and lead to productive discussion.

Any effort to make a list of Great Books is, of course, subject to criticism of various sorts. No list of Great Books is exhaustive. J. Winfree Smith, a faculty member at the College in the early years of the New Program, was careful to emphasize in his history of St. John's Program that the curriculum is "based on the reading of 'great books,' not '*the* great books,' since they do not constitute a fixed canon" (Smith, 1983, p. 1). The list that St. John's used in the first year of the New Program was based on that devised by Buchanan for the never-instituted Virginia Plan. That list, in turn, was based on other lists from earlier programs.[6] Objections can be made to any list. Some objections are local and limited, claiming that this or that book has been included (or excluded) while another has been excluded (included). These discussions

6 Buchanan gave credit to lists compiled by John Erskine in 1920 at Columbia and another by Sir John Lubbock prepared for the Workers and Mechanics Institute in England, published in 1895 (Smith, 1983, p. 10).

are frequent at St. John's, especially about newer texts.[7] A summary of the current undergraduate reading list is given as an Appendix II to this article.[8]

Other critics of the St. John's Program argue that lists of Great Books such at that used by the College focus too much on the views of privileged persons, often characterized as "dead white males," and systematically exclude the views of disadvantaged social groups. To some extent such concerns are addressed by increased sensitivity to works of women and minorities, especially among recent works.[9] Older texts, however, necessarily reflect in some degree the social structures of their times: literature in ancient societies was almost exclusively the work of dominant social groups, i.e., in the West that meant well-to-do free males.[10] Some Program writers express

7 The older the text, the more likely that agreement can be reached about its significance even by those who disagree with its content. Even those who reject Plato's idealism agree that *The Republic* is an essential text for Western thought because it defined the terms of philosophical discussion for centuries. Similarly, it is important that students read and reflect upon the significance of the Bible regardless of their attitudes toward religion because so much of the literary, social and philosophical works of the Western world have been shaped by Biblical ideas. What is or is not important in the writings of the last hundred years is harder to discern. For this reason, few works of the last century are assigned. Only four works on the current undergraduate reading list were published after 1915 (Freud, *Introductory Lectures in Psychoanalysis* [1917], Virginia Woolf's *Mrs. Dalloway* [1925], Heidegger's *Being and Time* [1927] and Wittgenstein's *Philosophical Investigations* [1953]). In any event, placing a book on the reading list is not equivalent to endorsing its contents, but only acknowledges the value of discussing it. Some faculty members take comfort in the reflection that any work that supports serious conversation provides a valuable educational experience.

8 For a comparison of how the St. John's reading list has changed in the years since the institution of the New Program, see Rule (2009).

9 Admittedly, all the authors on the St. John's reading list are dead. Some were not men (e.g., Jane Austen, Virginia Woolf). None of the authors on the Eastern Classics reading list are "white," and the undergraduate reading list includes a few nonwhite writers (W. E. B. DuBois, Frederick Douglass). However, it remains true that the majority of works on the St. John's reading list were written by persons in privileged social situations.

10 Not exclusively, of course. Epictetus was a slave. Socrates was not especially well-to-do (although Plato was).

views that are outside the pale of today's acceptable opinions: Aristotle, for instance, speaks in favor of natural slavery, and the letters of Paul in the New Testament contain passages that have been cited to support the oppression of homosexuals. Here we have to acknowledge that the Great Books that exist are, necessarily, the Great Books *of the past*. The culture in which we live, while a living offshoot of the past, is always becoming something new. One has to recognize finally that the roots of our present traditions do not in all cases resemble the leaves. For better or for worse, whatever views the majority now holds grew out of views that the majority now does *not* hold. Nonetheless, Aristotle can be read, studied, and even admired without accepting all his views. The books of the St. John's program do not all agree with one another, much less with current popular opinion, and students can study and profit from them without necessarily agreeing with them. A candid approach to the past is not a flaw in the Program but a strength.

Discussion Classes. Another principle of the College is that learning takes place from active participation in conversation, not from passive hearing of lectures followed by recital of the information heard. A longtime faculty member and former dean of the Annapolis campus expressed the importance of conversation to the College: "[f]rom the beginning our prevailing and pervasive mode has been conversation. Conversation is the public complement to that original dialogue of the soul with itself that is called thinking" (Brann, 1991).

Every classroom at St. John's, on both campuses, contains a large table surrounded by chairs, a setting for face to face discussion. Every class, whether a seminar on a literary, philosophical or historical work or a mathematics

tutorial, is an occasion for discussion of a shared text, or occasionally a shared experience. Every student is expected to contribute regularly to the discussion; not to do so risks poor grades and dismissal from the College.

A St. John's College classroom always contains a large table for discussion.

There are no lecture classes at St. John's. No classrooms have the rows of chairs facing a speaking station that are customary at most schools. The only lectures that regularly take place at the College occur on Friday evenings. These consist of public lectures that are open to the entire community and the interested public. Attendance is not taken. Topics range widely. Occasionally an attempt is made to coordinate the lecture with topics being discussed in one or another of the seminar classes, but more often the subject matter has no explicit connection to what is occurring in seminars or any other classes. In keeping with the idea that learning should be active, the lectures are always followed by a lengthy question period, often much longer than the lecture itself, in which students and faculty members probe the lecturer. They are called "question periods" and not "question *and*

answer" periods because it is not assumed that the lecturer will simply provide answers. A question period is deemed a special success if it provokes a seminar-style conversation involving give-and-take between and among the lecturer and the audience.

The College's almost exclusive reliance on active student discussion aims to enliven the student's connection with the texts being read. It is consistent with the experience of Buchanan at the People's Institute in New York where he found that lively participation in conversation was a reliable indicator of active learning. The value of this insight has been borne out by years of practice at the College in Maryland and New Mexico. In my own experience, it was borne out again in the classes that my wife and I led at the Dalton Academy in Beijing. To be sure, many students in those classes felt a strong inhibition preventing them from speaking actively in class. Whether that reluctance sprang from linguistic anxiety about speaking in a foreign language, from prior habituation to passive educational practice or from some characteristically Chinese reluctance openly to express disagreement in order not to disturb "harmony"—all theories that we contemplated from time to time in our stay—by the end of a few months many students were comfortably and eagerly discussing readings that we placed before them. In my 10th grade (高一) humanities class, I relied heavily on the reading of Platonic dialogs to impress upon students the message that a memorable and valuable class session might consist only of unanswered questions, and end with no final resolution, only a spur to further and deeper thought. Students resisted at first, but finally learned to tolerate and even like Socrates, whom one student referred to as "Mr. Question."

Unity of the Curriculum. One of the most striking features of the St. John's Program is the near total lack of electives. The curriculum is fixed; the student faces no decisions about majors, minors or classes to be taken. The St. John's Program is the antithesis of the Elective System.

The chief virtue of the unified curriculum is that it allows the College to form a single community of learning. For the students, that means that any student can go to any other student of his or her class or in higher classes for assistance with any classwork. So, for example, all Sophomores study the mathematician Apollonius of Perga simultaneously. All Juniors begin their reading of Kant's C*ritique of Pure Reason* at the same time. Because all students share work on the Program, conversation in the dining hall or the coffee shop is as likely to be concerned with aspects of the Program as with pop culture, which is the only shared experience for students in other schools.

Unity of the Curriculum also means that the subject matter of any class can be referred to and discussed in any other class. Topics of human inquiry are not arbitrarily divided into class subjects. At St. John's, any class may be related to any other class. So, Aristotle's idea of *entelecheia* (actuality) may come up naturally in a biology laboratory; it can equally arise in a math class. Pascal may show up in discussions of Faulkner; Ptolemy may be referenced in order to sort out ideas of quantum mechanics, and so on. Thought can range freely over all topics and make connections wherever they seem appropriate. The boundaries of electives and specialties do not constrain discussion.

Non-Specialization of the Faculty. An immediate consequence of the Unity of the Curriculum is that the faculty cannot be specialized.

If a student might refer to rules of 17th century counterpoint in mathematics class—as happened recently in my experience, the teacher must be willing and able to accommodate and respond to the connection. Ideally therefore all members of the faculty teach *all* classes in the curriculum. This necessarily means that, in many cases, a faculty member will be leading a class outside his or her area of special study. It is for this reason that faculty members are called "tutors," not "professors." The faculty is expected to lead the students in inquiry about the subject matter of the class, not to provide detailed expert knowledge. Thus they do not "profess" a subject and are not "professors." When new faculty arrive at the College they often begin teaching Freshman classes in which, regardless of their educational background, they are learning alongside the students. They are encouraged to expand their work in the Program until they have gained experience in all classes.

Just as any student can go to any other student for assistance, any faculty member doing any class can seek assistance from any other colleague who is doing or has done that class. Also, such collegiality is not inhibited by professional pride: every tutor knows the experience of working outside the area of his or her expertise. It often happens that a mathematics tutorial is led by someone whose graduate work was in literature or political science. In such circumstances, tutors learn to take advantage of colleagues who have already worked on the same material. Seeking and giving collegial assistance is routine at the College.

There is no interdepartmental competition because there are no departments. All tutors hold the same position and have the same interest in

teaching the Program. The centrifugal dynamic that makes general education the orphan in other institutions where faculty members are motivated to advance in their special fields does not occur at St. John's College.

Science and Math Are Liberal Arts. Mathematics and science are integral parts of the curriculum at St. John's College and are approached in the same way as other subjects, by reading and discussing classic texts. For some, this is the most surprising feature of the St. John's Program. "Liberal arts" are often thought of as standing in opposition to STEM (science, technology, engineering and mathematics) subjects. At St. John's, however, the liberal arts have always been understood to include both the subjects encompassed by the medieval "triviuum" (Grammar, Rhetoric and Logic) and the "quadriviuum" (Arithmetic, Geometry, Music and Astronomy). In modern terms, St. John's believes that the "liberal arts" include everything that engages the reflective mind. Liberal arts must therefore necessarily encompass mathematics and science. Indeed, since the scientific revolution of the 17th century, the issues raised by the conflict between humanist and scientific visions of the world, whether those conflicts are real or only apparent, are central to a complete education. Those questions cannot be approached responsibly without both an understanding of the scientific enterprise and grounding in humanistic thought.

St. John's College approaches mathematics and science through classic texts. This, too, surprises some critics of the Program who believe that, that while classic texts of literature or philosophy may still be valuable, mathematics and science are cumulative projects in which new

discoveries simply replace old ideas which then have no further value.[11] Such objections misunderstand the purpose of studying mathematics and science as liberal arts. The mathematics tutorial of the College seeks to provide occasions for students to reflect on the nature of mathematical thinking as a human activity, not to place them at the forefront of modern mathematical research. Students who eventually go into graduate research in mathematics must of course ultimately get up-to-date in the field of their specialty, but that is the task of graduate school, not undergraduate education. Undergraduate education, as a first step toward creative and original work later, should provide students with a grasp of the nature of the logical rigor that is essential to mathematics, and that is the focus of the St. John's approach.

For this purpose, classic texts are preferable. Euclid's *Elements*, the 3rd-century B.C. treatise of Greek mathematics that served as an authoritative exposition of elementary geometry and number theory for over two thousand years, is unsurpassed as an introduction to mathematical reasoning. Its accessibility and clarity stand as models of logical thought. The spectre of Euclid's *Elements* looms over other subjects in the St. John's curriculum as if tacitly demanding why ethics, politics and aesthetics cannot be expressed with the same compelling rigor that characterizes geometry. Even the flaws in Euclid's book are valuable. When in the Senior Year students read Lobachevsky's *Theory of Parallels* (1830), which explores alternatives

11 American philosopher Sidney Hook, in a 1944 article about St. John's, articulates this objection to approaching mathematics and science through classic texts: "The historical classics in mathematics and science are often written in an outmoded notation. Works of genius as they are, they are also full of false starts, irrelevant bypaths, and blind alleys. The science of our day has already extracted the rich ore and put it in a form which facilitates more rapid comprehension and further progress" (Sidney, 1946).

to Euclid's fundamental postulates, or David Hilbert's *Foundations of Geometry* (1900), which exposes logical gaps in the earliest propositions of Euclid's work, they are driven powerfully to question how logical arguments that seemed so compelling could be flawed or incomplete. They are led to wonder at the nature of logic itself.

Perhaps the text that most vividly illustrates the St. John's approach to mathematics and science is Ptolemy's *Almagest*, the presentation of geocentric astronomy composed in 2nd-century A.D. Alexandria. Ptolemy's work is a brilliant and compelling application of geometrical science to the phenomena of nature, *viz.*, the motions of the stars and planets. It is made all the more interesting because students know that his entire approach to the subject was overthrown and replaced in the 16th and 17th centuries by the work of Copernicus, Galileo and Newton, who are studied in the Sophomore and Junior years. Yet Ptolemy's geometry is correct and his work serves as an ever-present touchstone for reflecting on how mathematics can structure our understanding of nature. The *Almagest* routinely returns in conversations as students later study Einstein's Special Theory of Relativity and Quantum Theory in their Senior Year.

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Practices of the College

The Undergraduate Program. Carrying out the principles described above, the College has crafted an undergraduate curriculum consisting of four classes each semester. With very minor exceptions, all undergraduate

students in the same level (Freshman, Sophomore, Junior, Senior) take the same classes. These classes consist of the following:

Seminar. The Seminar is the central class of the Program. It extends through all four years and meets twice a week, on Monday and Thursday evenings, for two hours. Classes consist of two faculty members and about seventeen to twenty students. For each session, the students will have read in advance a prescribed text listed on the Seminar Reading list.[12] The sessions begin with an opening question posed by one of the faculty. Conversation then continues in whatever direction the class deems important. The tutors participate along with the students, occasionally intervening to keep the discussion focused on the text or to highlight or revive questions or issues that seem especially valuable. Seminars are scheduled for two hours, but often last longer if the conversation becomes animated.

Freshmen begin by reading Homer's *Iliad*, divided over four seminar sessions. Readings continue more-or-less chronologically through four years, ending with readings in 20th century literature and philosophy in the Senior Year.

For eight weeks in the Junior and Senior years, seminars are suspended and replaced by "**preceptorials**." These are seminar-like classes led by a single tutor in which usually a single text is examined more slowly than the seminar format permits. Preceptorial selections are the only "electives" that undergraduate students choose.

12 A summary of the reading list of the College can be found as Appendix II to this article.

Tutorials. Other classes, called "tutorials," occur during weekdays and are of three kinds: Language, Mathematics and Laboratory. During the Sophomore year, the Laboratory tutorial is replaced by a Music tutorial. Tutorials meet three times a week and consist of a single tutor and between twelve and sixteen students.

In the **Language** tutorial, students work on close reading of texts with special reference to means of expression. In the Freshman year, all students learn the elements of ancient Greek and spend time translating texts that are also read in Seminar. Study of Greek provides perspective on grammar, which many students grasp more readily in a foreign language than in their native tongue. It also allows students to reflect on the decisions made by the translators of texts which they read in their Seminars. The study of Greek continues in the first semester of the Sophomore year, culminating with slow reading of a major work of literature such as Sophocles' *Oedipus Rex* in its original language. The second semester of the Sophomore year is devoted to English literature, including reading of Chaucer's *Canterbury Tales* in its original Middle English and the careful, prolonged study of a play by Shakespeare.

In the Junior year, students acquire a reading knowledge of French and study works of French literature culminating in a reading of Racine's *Phèdre*. The study of French continues in the first semester of Senior year; in the last semester, attention turns usually to modern English language poetry and short stories.

The **Mathematics** tutorial begins with a reading of Euclid's *Elements*, which takes all of the first semester and part of the second. Afterwards,

attention turns to Ptolemy's *Almagest*, a project that generally extends into the first semester of the Sophomore year where it is followed by a reading of works by Copernicus and Kepler, detailing the replacement of the geocentric by heliocentric world-views. The most extended project of Sophomore mathematics is the *Conics* of Apollonius of Perga, a brilliant integration of three dimensional geometry and ratio theory which is not only interesting in its own right but essential for later readings. The Sophomore year concludes with Descartes' *Géometrie*, the text that married algebra and geometry to produce modern analytic geometry.

Much of the Junior year is given to the study of calculus based on a reading of Sir Isaac Newton's *Principia Mathematica*, a difficult but essential work in which infinitesimal methods are expressed geometrically in order to allow astronomy to be understood as a branch of elementary mechanics. The overwhelming triumph of Newton's mathematical physics in explaining everything from the motions of comets to the tides set the stage for the 18th century's celebration of human reason and essentially created physics in the form still taught in schools. In the Senior year, the mathematics tutorial studies Einstein's theories of relativity, beginning with his 1905 paper *On the Electrodynamics of Moving Bodies* in the first semester; in the second semester, the tutorial turns to non-Euclidean geometry and to Gödel's theory of the incompleteness of formal logical systems.

More students probably come to St. John's *despite* rather than *because* of the required four-year mathematics program; however, many students who were apprehensive of the mathematics program learn to love it. When studied as the exemplar of reason in its clearest form—rather than as a set of tools to be acquired quickly and with as little understanding as possible—

mathematics reveals itself as an exploration of beauty displayed in rigor and abstract symmetry.

The **Laboratory** in the Freshman year is devoted to observational biology in the first semester of the Freshman year and to chemistry in the second semester, examining Antoine Lavoisier's classic treatise *Elements of Chemistry* and culminating in Mendeleev's development of the periodic table of the elements. In the Junior year, the first semester examines elementary mechanics as developed by Newton, Leibniz, Huygens and elementary thermodynamics through works of Sadi Carnot and J. C. Maxwell. The second semester turns to electromagnetism chiefly through works of Michael Faraday and J. C. Maxwell, culminating in the Maxwell equations and the demonstration that electromagnetic radiation has the speed and characteristics of light. In the Senior year, students study early quantum theory in the first semester and genetics in the second semester.

In the Sophomore year, the Laboratory is replaced by a **Music** tutorial. Students learn fundamentals of music theory in order to study works by J. S. Bach, Mozart, Beethoven and Wagner, among others.

Evaluation. Typically there are no examinations at St. John's. Students are evaluated in each class according to their participation in class discussion and papers submitted. Each semester, students meet with all their tutors in a "Don Rag," a fifteen to twenty minute session in which the tutors describe and discuss the student's performance in each of their classes and offer praise or admonishment as appropriate and suggestions for improvement. By means of the Don Rag, as well as other informal consultation, all of a student's tutors are aware of the student's work at the College as a whole.

During the student's Senior year, he or she writes an extended essay that is submitted to a committee of three tutors. If the essay is accepted, the student undergoes a formal, public hour-long examination on the paper. These examinations, open to the entire College community, are often the highlight of the second semester. Successful completion of this examination is often celebrated as the culmination of the student's work at the College with champagne on the College Library steps.

The Graduate Institute

In addition to the undergraduate curriculum, since 1967 the College has had a **Graduate Institute** (the "GI"). Originally intended primarily for continuing education of teachers, the GI allows students already holding a bachelor of arts degree from another school to participate in the St. John's Program. In order to allow flexibility for students not studying full-time, courses in the GI are arranged according to subject matter—Literature, Politics and Society, Philosophy and Theology, Mathematics and Natural Science, and History—and are studied in one-semester units that students can approach in any order they wish.

In 1994, the GI in Santa Fe began offering a GI Master of Arts program in Eastern Classics. A three semester seminar program follows a reading list of classic texts from India, China and Japan.[13] Along with the seminar, students take a sequence of "preceptorials" in which longer and more demanding texts are read more slowly than the seminar allows. Also, students are required to

13 A summary of the reading list of the Eastern Classics program can be found as an Appendix I to this article.

take tutorials in either Classical Chinese or Sanskrit.

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Reflections on the College

No living institution simply reflects the thoughts of a single person. Even an institution like St. John's College that has grown from specific and identifiable intellectual roots attracts people who come to it for distinctly different and varied reasons. Not all St. John's faculty members—and certainly not all students—profess a single ideal of education or understand the mission of the College identically. Even those who have very similar ideas might express them differently. The College has remained fundamentally faithful to its founding purpose: it is still a dissenting presence in the landscape of American education, proclaiming to any who would listen that there is an alternative to textbook-and-lecture-based, information-directed education. Nonetheless, the reasons that attract faculty and students to an existing institution may differ in some ways from the motives that led its founders to create it.

Some feel sympathetic to the St. John's Program for **epistemological** reasons. The Program takes a generally chronological approach to the material studied. They believe that we cannot really understand the ideas that we hold unless we re-awaken the historical process that led to them.

> The end of all our exploring
> Will be to arrive where we started

And know the place for the first time.

(T. S. Eliot, *Little Gidding V*)

The German philosopher Edmund Husserl described the way in which once novel and interesting ideas become "sedimented" in language and common belief so that their original power and interest is lost (Husserl, 1970, p. 52). Reliving the immediacy of ancient thought effects a sort of "desedimentation" that revives the roots of experience that otherwise might remain unconscious and thus unavailable for understanding. This is one on-going reason that brings people to the St. John's Program.

Others are attracted to St. John's for its **conservatism**. The College takes seriously traditions and ideas that many believe are too often forgotten, overlooked or despised by the modern world. What is modern and up-to-date is not always right or good. For instance, some followers of the political scientist Leo Strauss find the College congenial because, in taking seriously the writings of ancient authors, it does not presume prematurely that more recent ideas are always better than those that they seem to have replaced. Strauss, who was a scholar-in-residence at St. John's College in Annapolis at the time of his death, believed that "Liberal education is education in culture or toward culture." Since the great teachers of culture are historically rare, Strauss said, modern students "[f]or all practical purposes . . . have access . . . to the greatest minds, only through the great books" (Strauss, 1967, p. 73). Strauss was an extraordinarily close reader of ancient texts and instilled in his students a respect for old texts that resides comfortably at St. John's.

It may seem paradoxical, therefore, that still others are attracted to the College for the **radical freedom** it permits its students. Although the

College prescribes in detail what books its students are to read, it makes no effort to dictate what they are to think about them.[14] I came to the College as an undergraduate in 1973. At the time, I was vaguely aware of the chaotic voices in the culture around me. All sorts of theories were on offer from different directions—some violently political, others religiously enthusiastic, still others scientifically confident—making conflicting claims and pressing urgent agendas. St. John's College did nothing of the sort. It offered no doctrine or dogma. The Great Books themselves do not speak with a single voice: books on the St. John's reading list support capitalism (Adam Smith) and communism (Karl Marx), religion (St. Paul) and atheism (Friedrich Nietzsche), expedience (Machiavelli) and principle (the Bible). The College's message was that *the students* would be trusted to read and evaluate these conflicting messages for themselves with no textbooks as guides and with tutors whose function is to ask questions and not to furnish answers. To place such trust in the students is a radical step, but the only way to help students learn to think for themselves, freely, is to offer them practice in doing so.

The deepest attraction of the College, however, is the **beauty** of the ideas studied there. None of the other motives—desedimentation, conservatism, radicalism and others that I have not mentioned or thought of—occupy the minds of the College's students and faculty on a daily basis. When engaged in the work of the Program, what is most evident is the inherent

14 This freedom applies even to scientific and mathematical texts. St. John's College probably has more students who have studied the calculus *but who do not believe in it* than any other institution in the world. Elsewhere most students either avoid studying calculus or learn it for its unquestioned utility. Relatively few schools require their students to study the subject but encourage them to reflect on the questionable maneuvers that its 17th century inventors employed to create it and whether later mathematicians have adequately repaired its doubtful foundations. See Berkeley (1734).

intellectual excitement evidenced in each work examined. The authors of the Great Books wrote these books, poems, and compositions because the ideas contained in them were compelling, and intrinsically beautiful. At St. John's, we read and discuss them for the same reason. Whether a student is demonstrating the infinitude of prime numbers (mathematics), contemplating Descartes' demonstration of the existence of God (philosophy), reflecting on Newton's discovery that gravity is the force that holds the Moon in its orbit (physics) or reading Prince Hamlet's soliloquies (literature), the work of the College furnishes constant reminders that intellectual reflection in all its forms provides opportunity for the experience of unparalleled beauty.

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Appendix I. Eastern Classics Reading List

The following is a summary of texts read in the Eastern Classics Seminar. Students also read Sima Qian's 司馬遷 *Shi Ji* 史記, *Tale of Genji* and selections from the *Mahabharata* in required preceptorials. A more detailed list of readings is available at http://www.sjc.edu/academics/graduate/master-s-eastern-classics/

- Confucius (Kongzi 孔子), *Analects*
- Mozi 墨子, *Writings*
- Mencius (Mengzi 孟子), *Writings*
- Xunzi 荀子, *Writings*
- Zhuangzi 莊子, *Writings*
- Laozi 老子, *Dao de Jing* 道德經
- Han Feizi 韓非子, *Writings*
- *The Rig Veda*, *selections*
- *The Upanishads—Katha Upanishad, Kena Upanishad, Mundaka Upanishad Brhadaranyaka Upanishad*
- *Nyaya Sutra*
- *Vaisesika Sutra*
- *Padarthadharmasamgraha*
- *Tattva-Kaumudi*
- Patanjali, *Yoga Sutra*
- *The Bhagavad Gita*
- Kalidasa, *Kumarasambhava*, *Shakuntala*

- Anandavardhana, *Dhvanyaloka*
- *Purva Mimansa*
- Charvaka, *Writings*
- Buddhist Pali Sutras
- *Lotus Sutra*
- Nagarjuna, *Mulamadhamakarika*
- *Vimalakirti Sutra*
- Gaudapada, *The Great Karika on the Mandukya Upanishad*
- Shankaracharya, Commentary on the *Vedanta Sutras*
- Ramanujan, *Commentary on the Vedanta Sutras*
- Jayadeva, *Gita Govinda*
- *Diamond Sutra*
- Hui Neng 惠能, *Commentary on the Diamond Sutra, The Platform Sutra of the Sixth Patriarch*
- Zhu Xi 朱熹, *Writings*
- Wang Yangming 王陽明, *Inquiry of the Great Learning*
- *The Tale of the Heike*
- Kukai, *The Meanings of Sound, Word, and Reality*
- Sei Shonagon, *The Pillow Book*
- Kamo no Chomei, *Record of the Ten-Foot Square Hut*
- Dogen, "*Bendowa*," "*Bussho*," "*Genjokoan*," "*Uji*."
- Kenko, *Essays in Idleness*
- Basho, "*Journey of Bleached Bones in a Field*," "*Kashimo Journal*," "*Knapsack Notebook*," "*Sarashine Journal*," "*The Narrow Road to the Deep North*."

Appendix II. St. John's College Reading List

The following is a general summary of the readings of the St. John's Program in the year 2013–2014. The detailed seminar reading lists are available at the College's web-site, http: //www.sjc.edu/academics/undergraduate/seminar/

Freshman year

- Homer: *Iliad*, *Odyssey*
- Aeschylus: *Agamemnon*, *Libation Bearers*, *The Eumenides*, *Prometheus Bound*
- Sophocles: *Oedipus Rex*, *Oedipus at Colonus*, *Antigone*, *Philoctetes*, *Ajax*
- Thucydides: *Peloponnesian War*
- Euripides: *Hippolytus*, *The Bacchae*
- Herodotus: *Histories*
- Aristophanes: *Clouds*
- Plato: *Meno*, *Gorgias*, *Republic*, *Apology*, *Crito*, *Phaedo*, *Symposium*, *Parmenides*, *Theaetetus*, *Sophist*, *Timaeus*, *Phaedrus*
- Aristotle: *Poetics*, *Physics*, *Metaphysics*, *Nicomachean Ethics*, *On Generation and Corruption*, *Politics*, *Parts of Animals*, *Generation of Animals*
- Euclid: *Elements*
- Plutarch: "*Lycurgus*" and "*Solon*" from the *Parallel Lives*
- Antoine Lavoisier: *Elements of Chemistry*
- William Harvey: *Motion of the Heart and Blood*

- Essays by: Archimedes, Gabriel Fahrenheit, Amedeo Avogadro, Joseph Black, John Dalton, Stanislao Cannizzaro, Rudolf Virchow, Edme Mariotte, Hans Adolf Eduard Driesch, Joseph Louis Gay-Lussac, Hans Spemann, Guy Beckley Stearns, J. J. Thomson, Dmitri Mendeleev, Claude Louis Berthollet, Joseph Proust

Sophomore year

- The Bible
- Aristotle: *De Anima*, *On Interpretation*, *Prior Analytics*, *Categories*
- Apollonius: *Conics*
- Virgil: *Aeneid*
- Plutarch: "*Caesar*," "C*ato the Younger*," "*Antony*," and "*Brutus*" from *the Parallel Lives*
- Epictetus: D*iscourses*, *Manual*
- Tacitus: *Annals*
- Ptolemy: *Almagest*
- Plotinus: *The Enneads*
- Lucretius: *On the Nature of Things*
- Augustine of Hippo: *Confessions*
- Maimonides: *Guide for the Perplexed*
- Anselm of Canterbury: *Proslogium*
- Thomas Aquinas: *Summa Theologica*
- Dante: *Divine Comedy*
- Geoffrey Chaucer: *Canterbury Tales*
- Niccolò Machiavelli: *The Prince*, *Discourses*
- Johannes Kepler: *Epitome IV*

- François Rabelais: *Gargantua and Pantagruel*
- Giovanni Pierluigi da Palestrina: *Missa Papae Marcelli*
- Michel de Montaigne: *Essays*
- François Viète: *Introduction to the Analytical Art*
- Francis Bacon: *Novum Organum*
- William Shakespeare: *Richard II*, *Henry IV, Part 1*, *Henry IV, Part 2*, *The Tempest*, *As You Like It*, *Hamlet*, *Othello*, *Macbeth*, *King Lear*, *Sonnets*
- Poems by: Andrew Marvell, John Donne, and other 16th- and 17th-century poets
- René Descartes: *Geometry*, *Discourse on Method*
- Blaise Pascal: *Generation of Conic Sections*
- Johann Sebastian Bach: *St. Matthew Passion*, *Inventions*
- Joseph Haydn: *Quartets*
- Wolfgang Amadeus Mozart: *Operas*
- Ludwig van Beethoven: *Third Symphony*
- Franz Schubert: *Songs*
- Claudio Monteverdi: *L'Orfeo*
- Igor Stravinsky: *Symphony of Psalms*

Junior year

- Miguel de Cervantes: *Don Quixote*
- Galileo Galilei: *Two New Sciences*
- Thomas Hobbes: *Leviathan*
- René Descartes: *Meditations, Rules for the Direction of the Mind*
- John Milton: *Paradise Lost*

- François de La Rochefoucauld: *Maximes*
- Jean de La Fontaine: *Fables*
- Blaise Pascal: *Pensées*
- Christiaan Huygens: *Treatise on Light*, *On the Movement of Bodies by Impact*
- George Eliot: *Middlemarch*
- Baruch Spinoza: *Theologico-Political Treatise*
- John Locke: *Second Treatise of Government*
- Jean Racine: *Phèdre*
- Isaac Newton: *Principia Mathematica*
- Gottfried Leibniz: *Monadology*, *Discourse on Metaphysics*, *Essay on Dynamics*, *Philosophical Essays*, *Principles of Nature and Grace*
- Jonathan Swift: *Gulliver's Travels*
- David Hume: *A Treatise of Human Nature*
- Jean-Jacques Rousseau: *Social Contract*, *The Origin of Inequality*
- Molière: *Le Misanthrope*
- Adam Smith: *Wealth of Nations*
- Immanuel Kant: *Critique of Pure Reason*, *Foundations of the Metaphysics of Morals*
- Wolfgang Amadeus Mozart: *Don Giovanni*
- Jane Austen: *Pride and Prejudice*
- Richard Dedekind: *Essay on the Theory of Numbers*
- *The American Declaration of Independence*
- *American Articles of Confederation*
- *The Constitution of the United States of America*
- *The Federalist Papers*

- Mark Twain: *Adventures of Huckleberry Finn*
- William Wordsworth: *The Two-Part Prelude of 1799*
- Essays by: Thomas Young, Brook Taylor, Leonhard Euler, Daniel Bernoulli, Hans Christian Ørsted, Michael Faraday, James Clerk Maxwell

Senior year

- United States Supreme Court opinions
- Johann Wolfgang von Goethe: *Faust*
- Charles Darwin: *The Origin of Species*
- Georg Wilhelm Friedrich Hegel: *Phenomenology of Spirit*, "*Logic*" (from the *Encyclopedia*)
- Nikolai Ivanovich Lobachevsky: *Theory of Parallels*
- Alexis de Tocqueville: *Democracy in America*
- Abraham Lincoln: *Selected Speeches*
- Søren Kierkegaard: *Philosophical Fragments*, *Fear and Trembling*
- Richard Wagner: *Tristan und Isolde*
- Karl Marx: *Capital*, *Political and Economic Manuscripts of 1844*, *The German Ideology*
- Fyodor Dostoevsky: *The Brothers Karamazov*
- Leo Tolstoy: *War and Peace*
- Herman Melville: *Benito Cereno*
- Mark Twain: *The Adventures of Huckleberry Finn*
- Flannery O'Connor: *Selected Stories*
- Sigmund Freud: *Introductory Lectures on Psychoanalysis*
- Booker T. Washington: *Selected Writings*

- W. E. B. Du Bois: *The Souls of Black Folk*
- Edmund Husserl: *Crisis of the European Sciences*
- Martin Heidegger: *Basic Writings*
- Albert Einstein: *Selected Papers*
- Joseph Conrad: *Heart of Darkness*
- William Faulkner: *Go Down Moses*
- Gustave Flaubert: *Un Coeur Simple*
- Virginia Woolf: *Mrs. Dalloway*
- Poems by: W. B. Yeats, T. S. Eliot, Wallace Stevens, Paul Valéry, Arthur Rimbaud
- Essays by: Michael Faraday, J. J. Thomson, Hermann Minkowski, Ernest Rutherford, Clinton Davisson, Erwin Schrödinger, Niels Bohr, James Clerk Maxwell, Louis-Victor de Broglie, Werner Heisenberg, Gregor Mendel, Theodor Boveri, Walter Sutton, Thomas Hunt Morgan, George Wells Beadle and Edward Lawrie Tatum, Gerald Jay Sussman, James D. Watson and Francis Crick, François Jacob and Jacques Monod, G. H. Hardy