

MATH 110-02 – Algebra Through History
Syllabus – Fall 2019

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and by appointment

Course Homepage: <http://mathcs.holycross.edu/~little/AlgThroughHist/ATH.html>

Background

In a 2005 poll conducted in the US with a sample from the adult population, almost 40% of the people surveyed said they had actively hated mathematics in school. This was more than the proportion who said the same about any other subject. Yet simultaneously, another group of nearly 25% within the same sample said they liked mathematics more than any other subject. Those who held the second opinion often said it was the unambiguous, “right or wrong,” nature of mathematics that drew them to the subject. We can infer that something like this distribution of opinions is probably true for the population at large.

Of course, within that population, a few people even devote their lives to studying the subject, but (in my experience, at least) many of those who do would disagree strongly about what makes it appealing – most would point out the possibility of exercising real creativity to discover beautiful new patterns in the mathematical realm as the most attractive feature!

What is it about mathematics that creates such divergent reactions?

It is certainly true that most of the reactions to mathematics described above come from the way the subject is taught in elementary and secondary schools. For instance, consider the way you were probably taught to solve quadratic equations in algebra class:

$$ax^2 + bx + c = 0,$$

when simpler techniques such as factorization do not apply directly. If your training was typical, you were probably told that you “just need to memorize the quadratic formula:”

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}. \quad (1)$$

And then you were drilled, and drilled, and drilled some more on solving lots of equations that way. You may have developed a phobia about remembering the complicated formula and come to hate what should be a basic and important algebraic technique.

I think part of the problem here is that (1) seems to come out of thin air. The formula (1) also uses the full power (and potential ambiguity and scariness) of symbolic algebraic notation. There are an awful lot of questions that should come to mind when you start to dig deeper into what is going on here:

- Why are letters used in a formula like this?
- What is it about x that makes it a “variable,” and how is it different from the other symbolic constants a, b, c ?
- Does x have a value from the start?

- What exactly is the sequence of operations you need to do to evaluate the formula on the right?

Others might come to mind as well.

Bright students often ask these questions, but the teacher's response is often "don't worry about that—just memorize the formula, plug and chug." And woe unto anyone who makes a mistake finding x from the formula – that's when the teacher's red pen comes out! *Is it any wonder a lot of people end up hating mathematics?*

I personally believe that another aspect of the problem is that most students have no appreciation of

- how hard it was, and
- how long it took people

to come up with this compact and powerful symbolic form. They are just told to memorize the formula without any indication of how or why it is true or where it came from.

I don't necessarily want to claim that knowing the history of things like this is a panacea for learning that will solve all the problems of mathematics education. However, I do think that realizing that it took a lot of "fumbling around" before things like this were really understood and codified in the form we use now has to help some students. Real, smart people struggled in exactly the ways modern-day students still do, and mastering basic mathematics is more a matter of confidence and persistence than of possessing any sort of "innate talent."

So in MATH 110, one of our major themes will be an examination of where the algebra you have learned, in particular the quadratic formula (1), came from and how the historical development of algebra, (and geometry and arithmetic) might influence the ways the subject is taught.

We will do this by considering passages from some of the most important original texts, in as close as possible to their original form (but translated into English):

- some Old Babylonian problem texts – actual records of students learning mathematics in scribal schools from around 1800 BCE,
- several sections of one of the most famous Greek mathematical texts – the *Elements* of Euclid (around 300 BCE),
- the *Arithmetica* of Diophantus (around 250 CE), one of the first surviving attempts at a symbolic algebra
- the very influential *Hisab al-jabr w'al muqabala* (around 830 CE) of Muhammad ibn Musa al-Khwarizmi
- the *Ars Analytica* of François Viète, and
- *La Géométrie* of René Descartes.

Some Groundrules

Many class meetings will be devoted to discussions, or work in smaller groups, so your active participation will be important for the success of what we do.

- Please *turn off* electronic devices—cell phones, tablet or laptop computers—unless you are using them to take notes. If you do use a computer that way, please have *only* your note-taking application open during class. There might be a few times we will want to look up some information on the web, though, and in that case, a web browser is OK.
- No distracting or “provocative” clothing, headgear, or other personal items in class, please.
- In discussions, there may be times that you disagree with Prof. Little or with a classmate. Please feel free to express that disagreement and be prepared to say why you disagree and back up your ideas with evidence. But please keep the conversation civil and respectful.

Text

For historical background, I will be giving reading assignments from

- *Taming the Unknown, A History of Algebra from Antiquity to the Early Twentieth Century*, Victor J. Katz and Karen Hunger Parshall, Princeton U. Press, 2013, ISBN 978-0-691-14905-9.

More importantly, we will also be using a number of selections from original texts that you will be downloading from the course homepage in .pdf format (at no cost).

It is expected that all Holy Cross students will have textbooks and other required class materials in order to achieve academic success. If you are unable to purchase course materials, please go to the *Financial Aid* office where a staff member will be happy to provide you with information and assistance.

Course Schedule

A detailed day-by-day course schedule will be maintained on the course homepage (and will be accessible through the Moodle course management system). That listing is a tentative, evolving schedule, so it may change and you will probably want to refer to it frequently. Any important changes will also be announced in class well in advance.

Assignments and Grading

- 1) *Midterm exam* (20 % of course grade) – tentative date: Friday, October 25.
- 2) *Final exam* (30 % of course grade) – the final will be given at the established time for MWF 11 am classes, when that is determined.
- 3) *Individual problem sets* (about 5 through the semester – 15 % of course grade)
- 4) *Writeups from group project days* (about 5 assignments – 15 % of course grade)
- 5) *One medium-length paper (6-8 pages)* (information and guidelines to be distributed later) (20 % of course grade)

I will be keeping your course average in numerical form throughout the semester, and only converting to a letter for the final course grade. The course grade will be assigned according to the following conversion table (also see Note below):

- A – 94 and above
- A- – 90 - 93
- B+ – 87 - 89
- B – 84 - 86
- B- – 80 - 83
- C+ – 77 - 79
- C – 74 - 76
- C- – 70 - 73
- D+ – 67 – 69
- D – 60 - 66
- F – 59 and below.

Note: Depending on how the class as a whole is doing, some downward adjustments of the above letter grade boundaries may be made. No upward adjustments will be made, however. (This means, for instance, that an 85 course average would never convert to a letter grade of B- or below, although it might be a B+ in some circumstances.) If you ever have a question about the grading policy or your standing in the course, don't hesitate to ask me.

Advice On How To Succeed In This Class

A good “work ethic” is key. As you should be able to tell from the course description above, you do not need to be a “math genius” to do well in this course. But you will need to put in a consistent effort and keep up with the reading and assignments.

Come to class. Unless you are deathly ill, have a genuine family emergency, are away at a game or meet of a college athletic team, etc. plan on showing up here at 11:00 am every Monday, Wednesday, and Friday this semester. Many of the class meetings will be structured around discussions or student presentations. Your participation is expected and needed for the success of the course!

Take notes and use them. This may seem obvious, but it is worth saying! Used intelligently, your notes can be a valuable resource as you work on problem sets and prepare for exams.

Use the text, sources, and class notes actively. Reading about mathematics is not like reading a novel. You will probably need to read and think over things more than once. You may want to work through examples to understand some of the topics that we do.

Set up a regular study schedule and work at a steady pace. It's not easy to play catch-up in a mathematics course (even when the course is a non-majors course which is more about the history of mathematics than learning active mastery of a new mathematical subject). You should expect to budget at least 4.5 hours in a typical week for work outside of class. The best way to use your time is to do some reading from the books, and reviewing of class notes *every day*.

Most importantly, if you are having difficulty learning something, get help as soon as possible. You can do this by asking questions during class (any time something isn't clear), or seeing me during office hours.

The College Academic Honesty Policy

All education is a cooperative enterprise between faculty and students. This cooperation requires trust and mutual respect, which are only possible in an environment governed by the principles of academic honesty. As an institution devoted to teaching, learning, and intellectual inquiry, Holy Cross expects all members of the College community to abide by the highest standards of academic integrity. Any violation of academic honesty undermines the student-faculty relationship, thereby wounding the whole community. The principal violations of academic honesty are plagiarism, cheating, and collusion.

Plagiarism is the act of taking the words, ideas, data, illustrative material, or statements of someone else, without full and proper acknowledgment, and presenting them as ones own.

Cheating is the use of improper means or subterfuge to gain credit or advantage. Forms of cheating include the use, attempted use, or improper possession of unauthorized aids in any examination or other academic exercise submitted for evaluation; the fabrication or falsification of data; misrepresentation of academic or extracurricular credentials; and deceitful performance on placement examinations. It is also cheating to submit the same work for credit in more than one course, except as authorized in advance by the course instructors.

Collusion is assisting or attempting to assist another student in an act of academic dishonesty.

At the beginning of each course, the faculty should address the students on academic integrity and how it applies to the assignments for the course. The faculty should also make every effort, through vigilance and through the nature of the assignments, to discourage and prevent dishonesty in any form.¹

It is the responsibility of students, independent of the faculty's responsibility, to understand the proper methods of using and quoting from source materials (as explained in standard handbooks such as *The Little Brown Handbook* and the *Harbrace College Handbook*), and to take credit only for work they have completed through their own individual efforts within the guidelines established by the faculty.

The faculty member who observes or suspects academic dishonesty should first discuss the incident with the student. The very nature of the faculty-student relationship requires both that the faculty member treat the student fairly and that the student responds honestly to the faculty's questions concerning the integrity of his or her work.

If the faculty is convinced that the student is guilty of academic dishonesty, he or she shall impose an appropriate sanction in the form of a grade reduction or failing grade on the assignment in question and/or shall assign compensatory course work. The sanction may reflect the seriousness of the dishonesty and the faculty's assessment of the student's intent. In all instances where a faculty member does impose a grade penalty because of academic dishonesty, he or she must submit a written report to the Chair or Director of the department and the Class Dean. This written report must be submitted within a week of the faculty member's determination that the policy on academic honesty has been violated. This report shall include a description of the assignment (and any related materials, such as guidelines, syllabus entries, written instructions, and the like that are relevant to the assignment), the evidence used to support the complaint, and a summary of the conversation between the student and the faculty member regarding the complaint. The Class Dean will then inform the student in writing that a charge of dishonesty has been made and of his

¹NOTE: If in any doubt about what you plan to do or write violates academic honesty, PLEASE ASK!

or her right to have the charge reviewed. A copy of this letter will be sent to the students parents or guardians. The student will also receive a copy of the complaint and all supporting materials submitted by the professor.

The students request for a formal review must be made in writing to the Class Dean within one week of the notification of the charge. The written statement must include a description of the students position concerning the charge by the faculty. A review panel consisting of a Class Dean, the Chair or Director of the department of the faculty member involved (or a senior member of the same department if the Chair or Director is the complainant), and an additional faculty member selected by the Chair or Director from the same department, shall convene within two weeks to investigate the charge and review the students statement, meeting separately with the student and the faculty member involved. The Chair or Director of the complainants department (or the alternate) shall chair the panel and communicate the panels decision to the students Class Dean. If the panel finds by majority vote that the charge of dishonesty is supported, the faculty members initial written report to the Class Dean shall be placed in the students file until graduation, at which time it shall be removed and destroyed unless a second offense occurs. If a majority of the panel finds that the charge of dishonesty is not supported, the faculty members initial complaint shall be destroyed, and the assignment in question shall be graded on its merits by the faculty member. The Class Dean shall inform the student promptly of the decision made. This information will be sent to the students parents or guardians.

The Class Dean may extend all notification deadlines above for compelling reasons. He or she will notify all parties in writing of any extensions. Each instance of academic dishonesty reported to the Class Dean (provided that the charge of dishonesty is upheld following a possible review, as described above) shall result in an administrative penalty in addition to the penalty imposed by the faculty member. For a first instance of academic dishonesty, the penalty shall be academic probation effective immediately and continuing for the next two consecutive semesters. For a second instance, the penalty shall be academic suspension for two consecutive semesters. For a third instance, the penalty shall be dismissal from the College. Dismissal from the College shall also be the penalty for any instance of academic dishonesty that occurs while a student is on probation because of a prior instance of dishonesty. Multiple charges of academic dishonesty filed at or about the same time shall result in a one-year suspension if the student is not and has not been on probation for a prior instance of dishonesty. Multiple charges of academic dishonesty filed at or about the same time shall result in a dismissal if the student has ever been on probation for a prior instance of dishonesty. Suspension and dismissal are effective at the conclusion of the semester in which the violation of the policy occurred. Students may appeal a suspension or dismissal for reasons of academic dishonesty to the Committee on Academic Standing, which may uphold the penalty, overturn it, or substitute a lesser penalty. A penalty of dismissal, if upheld by the Committee, may be appealed to the President of the College.

Specific Guidelines for this Course

In this course, all examinations will be closed-book. No sharing of information with other students in any form will be permitted during exams. On group discussion write-ups, close collaboration with the other members of your group is expected. On the individual problem sets, discussion of the questions with other students in the class and with me during office hours is allowed, *even encouraged*. However, your final problem solutions should be prepared individually and the wording and organization of your final problem solutions should be entirely your own work. Moreover, if you do take advantage of any of the above options for discussion of problems with others, you will be required to state that fact in a footnote accompanying the problem solution. Failure to follow

this rule will be treated as a violation of the College's Academic Integrity policy. The paper will be a research paper like those you will probably have done in other, non-math classes. Include a full reference in a bibliography section at the end of your paper for all sources you consult, and use footnotes to identify any direct quotations or ideas taken from your sources when you did not develop them yourself. Information about the acceptable formats for doing this will be distributed with the paper assignments.

Some Additional Information and Groundrules

It is my intent that students from all backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a *resource, strength, and benefit*. It is my intent to present materials and activities that are respectful of diversity in all forms: diversity in socioeconomic status, ethnicity, nationality, religion, culture, political opinions, gender identity, sexuality, disability, age, etc. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally, or for other students or student groups.

The College policy on excused absences from class is available at

www.holycross.edu/sites/default/files/files/registrar/excused_absence_policy.pdf

Any student who feels the need for accommodation based on the impact of a disability should contact the Office of Disability Services to discuss support services available. Once the office receives documentation supporting the request for accommodation, the student would meet privately with Disability Services to discuss reasonable and appropriate accommodations (which might include extra time and/or distraction-free environments on examinations, services of a note-taker or sign language interpreter, etc.) The office can be reached by calling 508-793-3693 or by visiting Hogan Campus Center, room 215A.