

UBC MATH Degree Reform

We, a representative sample of mathematics students at UBC, believe the current Mathematics program to be in dire need of reform. This letter is a collection of our thoughts on the underlying issues of the mathematics degree as it stands, put together over the course of the last two months. We outline the structural issues we see with the program, discuss how these issues affect us, and offer a series of actionable changes that we argue will result in a much improved program.

Summary

The mathematics degree is not in a good state. First introductions to real analysis and abstract algebra are left until the third year, with only three proof-based courses (Honours Differential Calculus, Honours Linear Algebra, Mathematical Proof) serving as preparation - all optional. These are easily and unfortunately avoided by students, which we argue leads to the high rates of failure seen in what should otherwise be standard math courses: MATH 320 (Real Variables I) and 322 (Introduction to Group Theory) maintaining historical averages in the low 60s, with approximately half the class failing or dropping each. For courses core to an education in mathematics, such high rates of failure so late into a degree speaks to a remarkable lack of early preparation.

The vast majority of upper-year courses have percentage-based requirements. If students pass, but fail to meet the requisite percentage (usually 68%) in the appropriate courses, they are permanently blocked from ever registering in courses requiring such prerequisites, as retakes are not allowed for passed courses. With the averages of common prerequisites well below that 68% mark, the percentage prerequisites filter out substantial portions of the Honours cohort each year. This, in addition to UBC's assessment-based curricula measuring the proficiency of students via two or three separate days of examinations, midterm(s) and a final, can result in a single bad day ruining one's opportunity to proceed in their degree. Students are being set up for failure, and offered no opportunity to learn and grow from their mistakes.

Unlike in other Honours programs at UBC, the Honours mathematics degree is not just a more intensive version of the mathematics degree. It *is* the mathematics degree. Students in the ordinary MATH program are not required to take analysis or algebra - nor are they expected to, and most importantly nor are they *set up* to: the ordinary MATH program has students taking two full years of engineering calculus, with only one course requiring proofs in the first two years. The Honours mathematics degree suffers from similar issues; as previously mentioned, students on the Honours track do not take analysis and algebra until their third year. This results in a backloaded and unbalanced degree: particularly as upper-year mathematics courses are intense, and taking a full load of them is broadly considered unwise. All of the above results in high rates of dropout from the Honours curriculum, which we allege below exacerbate the already-existing systemic biases in mathematics.

It is our opinion that students studying mathematics at UBC are often denied further education by a structure that systematically sets them up for failure. We wish to change this.

Current Issues

UBC MATH fails honours students

Talking to my peers I get the impression that a normal student (myself included) can take maybe two or three honours math courses each term before they get overloaded. This means the "standard" honours path has space for maybe 4 or 5 specialized courses, all in the fourth year, and I think that having this be the default is a total waste.

— /u/TheHolyRatKing (via Reddit)

As the degree stands, what are broadly considered the fundamental courses to an undergraduate education in mathematics - analysis and algebra - are locked to the third year behind prerequisite chains, with averages historically in the low sixties. The slow pace in the irrelevant prerequisite courses (we delve into this and the averages issue later) is in stark contrast with the later years of one's degree. Students exit their third year with an enormous amount of ground left to cover (topology, probability, harmonic analysis, and the like), and subsequently typically require a fifth year to be adequately prepared for graduate school. We consider this to be a major issue: having such key courses only accessible so late in one's degree causes even many of those who succeed in them to have to take an additional year to simply have enough time to take enough higher level mathematics courses, not to mention offering no leeway for those who wish to split them across years. To put it mildly, this is unfortunate. To put it harshly, the mathematics department fails to provide an appropriate undergraduate education for the majority of its (shockingly small) cohort of honours students.

AGAIN IN CASE ANYONE MISSED: REMOVE 68 IN 321 REQUIREMENT - ONE BAD TEST CAN REALLY DERAIL SOMEONES DEGREE / GRADUATE SCHOOL PLANS WHICH IS VERY UNREASONABLE ESPECIALLY SINCE THIS IS IN THE SECOND SEMESTER OF THIRD YEAR IN THE DEGREE PROGRAM

— Anonymous Student (via the UMS Discord)

The other and much more subtle way in which the department fails honours mathematics students is with regard to prerequisites. There exist a few key courses in which it is absolutely necessary for the future of one's degree to get above a 68% in - MATH 321 chief among them. If a student passes MATH 321 but fails to obtain the 68% requirement, they are *permanently* blocked from ever studying harmonic analysis, probability, real analysis, or topology while at UBC. Given MATH 321's historical average in the low sixties - over *half* of the students who have already succeeded in MATH 320 find themselves unable to take further courses in analysis. We find this - and similar percentage requirements - to be unnecessarily punitive. That passing a course does not, in the eyes of the mathematics department, constitute appropriate preparation for future study is worrying - but more importantly, these requirements are **antithetical to improvement**. The Mathematics Department should provide students who have low but passing grades an

avenue through which they can demonstrate improvement and proceed further along the mathematics program, rather than blocking them off entirely.

This is even ignoring the obvious: that the overwhelming majority of one's grade in a class is decided by the midterms and final. It is exceptionally easy to trip and have one bad day - which can consign an otherwise capable student to a grade below the threshold, which in turn blockades them from learning much of higher mathematics while at UBC: even if they have proven sufficient mathematical ability in other courses. Such prerequisites are appealable, of course - however, we believe that having to appeal prerequisites lends itself to systematic bias and favouritism. Appeals are necessarily a subjective process: and it is the impression of us, the student body (among us several students who have received such exemptions) that such exemptions are *seriously* contingent on favouritism. There does not need to be any favouritism for this to be a problem, however: appeals are a complicated process, and students made to feel less confident or unwelcome in math - notably women, and other minorities in math - will be far less likely to submit appeals. This additionally tracks with family history: first-generation university students may not even know such things are an option. And we believe that students should not be subject to such restrictions to begin with. We continue this discussion later - but UBC Mathematics is unique among both departments at UBC and mathematics departments across the country with regard to the stringency and ubiquity of its percentage-based prerequisites, and the department should consider why other departments *do not do this*.

UBC MATH fails majors students

The regular mathematics major is thus treated as a wastebasket of a major. It does not produce mathematically literate students. How can it, with analysis and algebra the way they are? I will be graduating with a mathematics major next spring: a degree in mathematics. I will be graduating without an undergraduate education in mathematics. What is there to do?

— /u/omentic (via Reddit)

It is the stated goal of the mathematics department for the mathematics major to produce mathematically literate students, while the honours degree is intended to prepare students for graduate school in mathematics. It is our opinion that the mathematics program fails at the former, and does merely an adequate job at the latter, in comparison to similar institutions. At the University of Waterloo, both majors and honours alike take an elementary course in number theory, two courses in abstract linear algebra: with the accelerated stream additionally requiring a fully rigorous approach to Calc I and II and a course on point-set topology in normed vector spaces, while all other students take a partially-rigorous (basic epsilon-delta arguments for sequences, series, and continuity) approach to Calc I and II: all by the end of their second year. At the University of Toronto, all prospective mathematics students take a proofs-based calculus course in the first year, with honours students taking a rigorous approach to analysis, and further covering Spivak's *Calculus on Manifolds* in their second year. All approaches lead to students having significantly more practice in formal mathematics by the end of their second year - honours students far ahead, but even majors covering content with as much rigor by the second year as honours students at UBC do. Their regular majors students are given the preparation to take analysis and algebra, and even topology, in their third and fourth years. Ours are not.

The regular mathematics degree lacks serious graduation requirements: nothing but the standard first and second year curriculum, and ten courses of upper-year MATH courses, is required to graduate. This is not necessarily a bad thing. A more flexible degree can be useful: allowing students to use the broad applications of mathematics to pursue more interdisciplinary studies. What we perceive as a major failing, however, is that majors students are not expected nor encouraged to take analysis and algebra. Whether or not these courses should be required is beside the point: students should have the *ability* to take more abstract math courses, and for many reasons that we have outlined above and will outline below, we do not believe that students are currently set up to do so. That is all to say - the changes we propose in this letter, to get students acquainted with proof earlier, *cannot* be confined to the honours degree. It would otherwise be a disservice to those unable or unwilling to pursue honours. It is not only reasonable, but imperative, to empower *all* mathematics majors to take rigorous courses in analysis and algebra if they so desire: if not in the second year, at least by the third year.

UBC MATH disproportionately fails women

Leaky pipeline: about 52%-70% of women leave the program before graduation, compared to only 32% of men.

— Dr. Coles and Dr. Piccolo (via their presentation)

[Two years ago, Dr. Coles and Dr. Piccolo gave a presentation on gender in honours mathematics.](#) They identified several key issues within the program and provided harrowing statistics that seriously condemn the mathematics pipeline at the university level. While mathematics as a field has well-known and serious problems of gender equity that occur before university, it is shocking to see the sheer scale at which such problems actively occur at UBC. The Department of Mathematics holds within it the power - and the responsibility - to change this.

We would like to highlight several points from the presentation in particular:

- ❖ Women were "encouraged to leave mathematics while struggling"
- ❖ "There was a lot of gate-keeping and posturing, it was gross"
- ❖ "The women identified a 'clique' of outspoken men who bonded in 1st year or earlier"
- ❖ Between 50-70% of women drop out of the program, in contrast to around 30% of men

We believe these to be overwhelmingly a **direct result of the mathematics department's pedagogical practices**. A lack of student support, particularly at the introductory level, is a tacit encouragement for students to drop the program, and disproportionately affects already underrepresented groups. This is not to mention that instructors in certain upper-year courses explicitly state that struggling students should drop the course or the program, which again, has a disproportionate effect on marginalized groups. The gate-keeping mentioned in the presentation already occurs internally within the department - it is a common attitude to consider MATH 320 and 322 to be the first "real" math courses, whether or not that is or should be true - and such an attitude rubs off on the student body.

It is no surprise, too, that such cliques form and solidify in reaction to the sheer wall that analysis and algebra at UBC present - and left to form naturally tend to be entirely composed of men given the existing gender skew. So other students, particularly women, do not find themselves with peers, and so find themselves with significantly less academic support. Other schools put pedagogical practices in place to socialize students and provide connections in first year math to prevent this isolation, but UBC makes no such attempt: despite this being explicitly outlined as a problem with an easily actionable solution in Dr. Coles and Dr. Piccolo's presentation. To our understanding, no action has been taken as a result of their presentation, and women continue to be overwhelmingly encouraged to drop out of the honours program.

The gate-keeping we believe to be the worst and most insidious part. It is the experience of us, the student body, that professors at UBC tend to label students as either "strong" or "weak", solely based on their performance in one or two key courses. Crucially, these labels are treated as static, unchanging features of the student's being, not a fluctuating measure they can improve in. Students who do poorly are discouraged from taking future math courses, are told they lack ability, and given very few paths to fill in a weak background. We understand that course performance demonstrates mastery of certain skills, but we object to the idea that performance in a few courses captures the entirety of how good a student is - or could ever be - at mathematics. There are a variety of reasons a student may do poorly in a course: particularly when their grade in such a course is so heavily determined by their performance on two separate days, a midterm and a final. This is not just damaging to those deemed "weak" or "mathematically inept", but also the few students the department sees as "strong": it gives the idea that one needs natural brilliance to succeed, and anything short of that is an irredeemable character flaw, unable to be corrected through hard work and practice. It is hard to see how the attitudes of one's peers could *not* be affected by the overall departmental attitude. And such intimidating and restrictive policies are only more disastrous for underrepresented groups.

Actionable Items

We have now presented several serious structural problems that we have observed over the courses of our degrees. **We believe that these problems are fixable.**

It is our understanding that much is out of the control of the mathematics department. There are certain issues only truly addressable within the Faculty of Science as a whole. Even the creation of new courses is not a task to be taken lightly: as per our understanding, these take years to be implemented. As such, we have kept our feedback contained to areas over which we believe the mathematics department has more control, and can be reasonably implemented in the short term. These prominently include:

- ❖ Prerequisites of courses
- ❖ Intended years of courses (course codes)
- ❖ Student support available within (certain) courses
- ❖ Graduation requirements of the degree

A course in proofs should be required for all prospective math majors

We believe that the Mathematics Department should require either MATH 120/121 or MATH 220, in the first year, for entry into the major.

MATH 120 is an exceptionally good course and taken by unfortunately few. It is a rigorous walk through standard first-year calculus, assuming little and making explicit that which one does assume, and introducing students to a variety of wildly different forms of mathematical proof. The course is well-structured, well-paced, and well-taught. It suffers a little for lack of a tutorial section, which we shall discuss later, but the broad consensus among mathematics students is that it is an excellent introduction to university mathematics.

MATH 121, however, suffers somewhat: it cannot assume familiarity with content covered in MATH 120, as students scoring high enough in MATH 100 may join at the semester mark, and it thus cannot teach to the same level of rigor as MATH 120. This is unfortunate. Working under the assumption that MATH 121 should be an appropriate follow-up course to MATH 120 (which we want - we will address this later), we see two venues for change: removing the ability to jump to MATH 121 from MATH 100, or providing explicit resources to let motivated students catch up on their own. As we shall address shortly, we believe that MATH 120 should be a general mathematics degree requirement, so we go with the former.

But to return to the issue at hand: mathematics students - majors and honours alike - overwhelmingly choose to skip out on MATH 120/121, either by taking MATH 100/101 (often due to scheduling constraints) or as a result of AP/IB credit. The current system of "strongly encouraging" "mathematically able" (more on the second pair of quotes here later) students to take the MATH 120/121 stream does not work. This is a real problem: particularly so because MATH 120/121 represent a full half of the rigorous classes and preparation available before MATH 320 and MATH 322. It should go without saying, but these courses are *thoroughly* different courses from MATH 100/101 / AP Calculus / etc, and should not be treated as equivalent for anyone intending to major in mathematics.

While we would like to say that MATH 120/121 should be mandatory for *any* prospective MATH major, explicitly disregarding AP Calculus or equivalent credit, this is infeasible. There are some groups of students for which taking MATH 120/121 is impossible. Science One students, transfer students from other institutions, and transfers from other majors fall into this group. However: we believe that the value of MATH 120/121 as an introduction to proof and specifically as preparation to MATH 320 cannot be overstated. While it is unfortunate that MATH 120 cannot be a degree requirement for such students, we think that MATH 220 instead offers a similarly good introduction to proof if taken early (if not as directly applicable to MATH 320), and is flexible enough to be a requirement for such students, though MATH 120/121 would be preferred.

We propose that either MATH 120/121 or MATH 100/101 + 220 become **mandatory for degree entry** for all mathematics majors, honours and majors alike. It must be emphasized that this is a mandatory requirement for potential majors, too. As addressed above, the mathematics department cannot continue to treat the majors program as a wastebasket of a degree. This also

somewhat addresses some issues that the mathematics department has had with students entirely uninterested in mathematics putting it down as a backup major for computer science. It allows for:

- ❖ an introduction to proofs to be taken in the first year
- ❖ students in MATH 100 who become interested in majoring in mathematics to address their mistake at the semester (by taking 220) without compromising MATH 121
- ❖ a *motivating* reason for students to take MATH 120/121 aside from them being "strongly recommended" (fewer classes make for a more convenient schedule).

This is a feasible requirement, on analogy with entrance requirements for the other programs in the Faculty of Science. In the MATH 120/121 case, students will receive significantly more preparation for MATH 320 than they currently do, as many do not take 120/121 to begin with, 121 currently suffers from a lack of rigour, and students currently suffer from being forced to take a year-long non-rigorous course on multivariable calculus as an irrelevant prerequisite to MATH 320. (We address this in detail shortly.) Students transferring into mathematics from another major or out of Science One will be less prepared (with only MATH 220), but there is no way around this. We address this in detail much later.

There is additionally one point of order: that of the late-drop from MATH 120/223 to MATH 100/221, respectively. This has supposedly always been around. This was not in the syllabus of any of our iterations of MATH 120, nor - given some context clues - does it have appeared to have been so much as mentioned in any of the subsequent or most of the preceding iterations of the course. It is not appropriately communicated to students, and it is dishonest to call it a "policy" when such a policy can only be triggered by a student who *does not know it exists*.

Algebra should be offered (much) earlier

As written our first two years have five analysis courses (4 calculus, one ODE) and only one algebra course (linear algebra), and it would be much healthier to have less analysis and more algebra (and move topology to third year).

— /u/liorsilberman (via Reddit)

MATH 220 and MATH 221/223 should be first-year courses. The content is self-contained. There is little reason to lock them behind an irrelevant prerequisite of first-year calculus. No concepts in either course depend on calculus, and it is hard to imagine that the department is unaware of this. It is our impression that the department internally somewhat considers them to be first-year courses: and they are indeed accessible first year for those with AP/IB credit. But why have such a requirement, then? Even if they are supposed to be treated as first year courses, course numbers *mean* something. We are sure that swaths of eligible first years have passed these courses by, delaying their mathematical education - and again, we do not think there is any reason to *not* be eligible to take them.

Similarly, we believe MATH 310 should be a second-year course. This gives students who experience difficulty with the more rigorous entry to mathematics outlined in this letter an opportunity to spread it out over their first two years, while still leaving time for them to take abstract algebra, and a follow up course.

Calculus should be (much) condensed

UBC, on the other hand, has a bullshit calc sequence that's built for engineers. You don't do proofs until your second year (????), and the linear algebra courses seem super computational, not abstract or the way a mathematician thinks about it.

— /u/blank_anonymous (via Reddit)

There is entirely too much calculus required in the first years of the university curriculum. We have differential calculus, integral calculus, multivariable calculus, vector calculus, and ordinary differential equations, all required in the first two years of the mathematics degrees. These are also all non-rigorous courses with little to no practice in mathematical proof, and none of them - save the skippable MATH 120/121 alternatives - provide any sort of appropriate preparation for the courses that need it: MATH 320 and MATH 322. We unfortunately do not think it is feasible for them to *become* appropriate preparation, too, as we have heard bad things about curriculums that attempt to adopt *Calculus on Manifolds* or equivalents too early. However: by all accounts MATH 226/227 are nigh-identical to the majors MATH 200/317, and the content in them is sparse enough to be collected into one course - already existing as MATH 217! This, we think, should be the recommended path for honours students, with MATH 226/227 left for majors and MATH 200/317 left for students outside the Department of Mathematics.

The other major issue with calculus at UBC as it stands is the use of multivariable calculus (MATH 226) as a prerequisite for real analysis. We delve into this in detail in the next section, but we believe that a grade of 68% in MATH 226 is an entirely irrelevant prerequisite to MATH 320: not indicative of further success enough to be a reason to fully bar students from attempting analysis, and not providing for student preparation - and in fact is counterproductive, as it delays students already prepared via MATH 120/121 from taking analysis and further advancing in their degree.

Students should be (much) more heavily prepared for MATH 320

A: eh even below 60 is like

A: fine

A: i mean it's a weeder course

B: below 60 is absolutely not fine

B: and i would argue an average below 68 is not fine (👍)

B: but it's more acceptable

B: i also don't know what to think about a course being a "weeder" if it's a 3rd year course

C: Me when I get weeded out of my program with three years of esoteric math honours courses under my belt (😭)

D: why is the existence of weeder courses ok?

D: a sub 60 average in algebra 1 is absolutely insane to me 🤯

A: Oh, by no means am I convinced that it is

D: like ok, I guess I think weeder courses work towards the goal of your program selecting for some nebulous idea of "natural talent" whatever the fuck that means and more concretely for keeping upper year class sizes small

D: but I don't think they're particularly helpful to student learning

D: like I don't think a group theory course with an average in the 50's is accomplishing "only people who do well in this course are able to succeed in upper year courses"

E: I'm pretty convinced anyone can be good at math if they put the work into it

E: Classes of avgs in the 50-60 makes it pretty discouraging to put enormous amounts of work into it

E: I will mention that I don't think the content itself is the main weeder but rather the grading scheme

E: It's weird, math research involves a lot of collaboration and reading yet undergraduate math courses want to grade 50-95% of your work based on how well you do on an exam

— Anonymous Students (via the UMS Discord)

We now get to the heart of the issues at hand.

MATH 320 and 322 each have approximately a 50% fail+drop rate. For an introduction to analysis in the third year, covering the standard Rudin curriculum, to fail (in the educational sense) 50% of students who have *self-selected into mathematics already* is entirely unacceptable, and that this failure happens and is normalized for such interested students at all is a tragedy. The current state of MATH 320 (and MATH 322: though we believe that the issues with 322 are not structural and are out of scope for this letter) is *broken*. This does not appear to be an issue of difficulty: the content covered is completely standard, and similar courses at similar institutions taught to similar rigour do not see similar failure. Instead, we believe it to be one of preparation. Students enter MATH 320 horrifically underprepared for a rigorous treatment of analysis: the cause of which we outline shortly. The mathematics department is gatekeeping a standard mathematics education to the few capable of succeeding *quickly*: entirely failing those unable to catch up on two years of education in the span of one semester, and doing so not only at the expense of those who fail but also at the expense of those who succeed, and pass - who suddenly have to come to grips with the absolute necessity of leaving MATH 321 with at least a 68% in order to take any further courses in real or harmonic analysis, probability, and topology. This means that an otherwise capable but underprepared or unlucky student's future hope for their degree can be - and tragically, often is - derailed in the span of two bad days.

The problem here isn't that Math 320 is so hard -- the problem is that students aren't being prepared properly for or supported through real analysis, and so grade requirements are put in place. The analysis courses here aren't unusually hard, they're unusually easy and students do poorly, despite being strong. Talking like there's no way UBC could do this better is letting the university off the hook for what is, quite frankly, horrifying treatment of students.

— /u/blank_anonymous (via Reddit)

We believe this must change.

The MATH 226 prerequisite for MATH 320 is profoundly misleading: as discussed above, it requires students to spend a full year doing mostly computations, by virtue of the course content (calculus on manifolds) can offer little in the way of mathematical proofs for students at a second-year level, and so does not adequately prepare anyone for the rigour in which topics are covered in 320. As a prerequisite, it is entirely irrelevant: only serving to delay students' mathematical maturity. The lack of an explicit proofs-based course prerequisite (MATH 120/121, 220, or 223) results in a fair portion of students having their first introduction to fully rigorous

proof be *Rudin*. This, to put it mildly, sets students up for failure. We believe that the introduction of a prerequisite of a prior proofs-based course (MATH 120/121, 220, or 223) - and *only* that as a prerequisite - would significantly improve preparation of students dealing with analysis for the first time.

It must be emphasized that we do not believe there to be much in the way of structural issues *within* MATH 320: nor within MATH 226 or 227, for that matter. These are well-taught and well-appreciated courses. The issues around it that we have laid out here come from the inadequate prerequisite chain and unfortunate course code. We believe that it is possible for MATH 320 to be reasonably approachable by *all* mathematics majors with reasonable preparation. The existence of MATH 319 and a future MATH 329, then, we believe to be counterproductive, and taking up departmental resources that could be used elsewhere (we discuss this more later).

Percentage-based prerequisites should be (mostly) removed

i feel this way about every percentage requirement tbh. like, you should only need to pass courses, otherwise you're fucked because you can't retake passed courses

— Anonymous Student (via the UMS Discord)

We have addressed how the 68% in MATH 321 prerequisite adversely affects students, derailing many's future hopes for their degree unreasonably late in the program, without any path offered to catch up or redeem their grade. We now put forward that percentage-based prerequisites are undesirable in *any* circumstance - instead, we strongly believe they should be replaced with *recommended* percentages in such prerequisites, and require nothing more than passing. Students should be made aware of the difficulty of courses they are interested in, for certain. But they should not be permanently barred from future study: particularly given how UBC Math underprepares students in the first two years. There exist appeals: but we have addressed why this is inadequate and inequitable.

Percentage-based prerequisites are routine among mathematics courses offered at UBC at all levels. They are far from routine in other disciplines. Some quick checks suggest that well over 50% of courses with percentage-based prerequisites all fall under a MATH course code. They are also far from routine at other universities: both the University of Toronto and the University of Waterloo have no prerequisites with minimum grades exceeding 60% - a whole letter grade lower - and notably, those prerequisites are only in place for students jumping from the majors program to the honours pathway, and **students are able to retake courses for a higher grade**. It appears to us that these minimum percentages serve as a crutch - rather than fixing the (shocking) issues plaguing the first two years of the mathematics degree at UBC and providing an on-ramp, the Mathematics Department has instead placed a barrier in front of future educational prospects, artificially limiting the number of students who are given the opportunity to take upper-year courses.

We believe the mathematics department should take cues from other departments at UBC and across Canada: remove these requirements, and prepare students adequately. The Philosophy Department takes an approach with their formal logic courses that we find appealing: all courses

lack formal prerequisites, but instead have recommendations for prerequisites. MATH 402 and 403 do this. Their recommended prerequisites of *a score of 68% or higher in one of MATH 301, MATH 320, or a score of 80% or higher in MATH 319* appear on the SSC: students that struggled in those classes are made well-aware that they will have to put in the more work to succeed. But they are able to take them. A subpar grade does not exclude students from future study: and provides motivation to put more effort in. Lacking any sort of prerequisites we care less about - prerequisites are prerequisites, after all, for a reason - but removing percentage requirements on prerequisites is an issue of utmost importance to us, particularly given the Faculty of Science's well-known policy of disallowing retaking courses not failed.

MATH 120/121/220/223 should receive more department resources

Throughout this proposal, we have shied away from suggesting adding more resources (TAs, tutorials, and the like) to courses. While we expect this would (significantly) increase success rates of students, it is our understanding that the department is somewhat constrained on resources.

MATH 120/121, MATH 220, and MATH 223 are exceptions. As previously discussed, these should be first-year courses and highly encouraged if not outright required for all MATH majors. As such introductions to proof-based mathematics, there are no courses that could benefit more from increased student support. We believe that a mandatory tutorial would go a long ways in both courses: but department resources do not appear out of thin air, of course. We believe that properly preparing students for MATH 320/321 and MATH 322/323 would remove the need for a MATH 319 or future MATH 329, freeing up the funds to pay for the extra TAs a term.

Additionally, we believe that MATH 120/121 and MATH 223 should focus more heavily on group work. Little has to change but the assignment of mandatory groups for assignments. It is common already for students to band together - but letting students pick their own groups can and does lead to the formation of homogeneous cliques, as brought up earlier in our section on Dr. Coles and Dr. Piccolo's presentation.

Treating students as Good or Not Good is harmful to their growth

A: They gotta stop relying on 320/321 and 322/323 whipping people into shape

A: Put some care into first two years of math

B: 322/323 doesn't even do that

B: these courses are mental filter

B: who can survive the course that's going to ruin your mental health the most

C: And the problem is

C: Plenty of people could have succeeded

C: If they hadn't been shattered

C: I see a lot of profs at UBC talk like you are either Good or Not Good

C: And the point of grades is to figure out who is Good

D: Oh, I've had profs say that to me verbatim.

D: Professors talking about "strong students" and "weak students" is very typical.

E: this is sad

C: In fact in our teaching course the prof has explicitly said to stop using that language bc framing is super important

C: She said successful so far/unsuccessful so far or in terms of skills or whatever

C: “This student doesn’t know how to integrate by parts” is far more... helpful to think about

C: Than “this student is weak”

— *Anonymous Students (via the UMS Discord)*

We believe the mathematics department has an outdated, ineffective, and damaging approach to pedagogy. It is our universal understanding - through individual interactions with professors, all of our interactions with the department, and the structure of the degree as a whole - that it is commonplace to treat student ability as a constant, and to pour resources only into students who show promise early. This is a damaging and demeaning way to treat students: directly contributing to the ostracization of already discriminated groups, as discussed above - but more generally being *such* a horrible way to approach education. Students are only likely to improve if they are consistently treated as being able to improve, and if they are operating in a structure that allows for such opportunities for growth. The current system in place at UBC accelerates the students who excel quickly, are sure of their interest in mathematics from early on, and plan their course schedule in a very specific way: at the expense of everyone else.

Subsequent Schedules

What we have suggested so far are significant changes. We believe the degree dearly needs it. Something not explicitly mentioned so far, however, is that these changes are *deeply* integrated with one another. One cannot simply just move MATH 320 to second year and expect students to succeed. (Though as things stand, students would not be significantly less prepared, as we do not believe MATH 226 is effective preparation, as discussed above.)

For clarity's sake, we have put together examples of what a typical schedule for several categories of students would look like below. These are subject to individual variation, of course, but we think these would be reflective of the typical student.

Honours	
1st year	MATH 120/121, 223
2nd year	MATH 217, 215, 300, 320/321, 322/323
3rd year	MATH 320/321, 322/323, 300 if any were not already taken. Various 3rd and 4th year courses.
4th year	Various 3rd and 4th year courses.

Majors	
--------	--

1st year	MATH 120/121, 221, 220
2nd year	MATH 320/321, 226/227, 215, 310
3rd year	MATH 322/323, 300. Various 3rd and 4th year courses.
4th year	Various 3rd and 4th year courses.

Science One and Transfers	
1st year	Science One / first year calc
2nd year	MATH 220, 223, 217, 215, 300
3rd year	MATH 320/321, 322/323
4th year	Various 3rd and 4th year courses.

A distinct possibility for Science One and transfer students would also be to take MATH 220 in the summer term and fall into the same schedule as Majors or Honours.

Late Majors	
1st & 2nd year	MATH 100/101/equivalent
3rd year	MATH 220, 223, 217, 215, 300
4th year	MATH 320/321, 322/323
5th year	Various 3rd and 4th year courses

And for reference, the typical current honours mathematics degree:

Current Honours	
1st year	MATH 120/121
2nd year	MATH 226/227, 223, 215
3rd year	MATH 320/321, 322/323, 300
4th year	Various 3rd and 4th year courses.

Current Honours (with AP/IB credit)	
--	--

1st year	MATH 226/227
2nd year	MATH 320/321, 223, 215
3rd year	MATH 322/323
4th year	Various 3rd and 4th year courses

Inactionable Items

While we believe the majority of the serious issues we laid out in the first section are addressed by our proposals above, there are some that we think *should* be addressed in an ideal world that are not actionable by the mathematics department alone. We lay these out here.

The minimum credit requirement for Honours

A: Sorry can you elaborate on "take a certain number of credits"? not quite sure what you mean

A: like per year?

B: Yes

A: what the *fuck*

A: that's a horrifying requirement that shouldn't exist or have any influence on the type of degree you get

A: that's disgusting

B: This is across the faculty of science i think

A: That is wretched

B: Students in an hon's degree have to take 27 credits per winter session

B: Some of the problems here are definitely just faculty of science problems. Similarly the "no retakes for courses you passed" policy

A: I will beat someone to death with my bare hands

A: This is horrifying

A: This is like, one of the most "this policy will kill students" policies I've ever seen

C: Its genuinely discriminatory too

A: Massively and obviously

— Anonymous Students (via the UMS Discord)

That no one who has to work through school can graduate with honours distinction in the Faculty of Science is archaic and inequitable. The idea that the number of courses one is capable of handling in a term should have *any* bearing on their degree, as opposed to the pure quality of their work, is an inaccessible notion and disproportionately affects disadvantaged groups. There are exceptions of course - there is always someone able to balance full time employment and education - but the point is that no one should *have* to be subjected to that sort of workload.

And in other faculties, no one does. However, the mathematics department explicitly thinks of the honours degree as *the* route to graduate school, and has designed the curriculum accordingly. This, to our understanding, is a relic of the history of the Canadian university system more than

anything. But that does not mean that this is not a damaging attitude: while we have put it under the "Inactionable Items" section due to it directly being a Faculty of Science issue, we believe that the department should seriously reconsider their stance, and look to how mathematical pedagogy at other Canadian universities has changed over time. The requirement itself may be inflexible, but the status quo built atop it can and should be changed.

The "No Retakes" policy

Similarly, the Science-wide "No Retakes" policy for courses not failed is a reasonable policy in isolation, but combined with the strictly enforced percentage prerequisites of the mathematics curriculum makes for a brutally punishing program, offering no means to catch up, step back, or for most, even succeed. If a student passes, but scores below the percentage threshold for a prerequisite course, they are permanently barred from ever taking subsequent courses requiring it. This encourages students not confident in meeting the percentage prerequisite(s) to instead fail, allowing them to at least retake the course in the future, effectively making a passing, yet below percentage prerequisite, grade worse than failing. It sends the message that only those immediately able to succeed are worthy of proceeding in mathematics, and that mathematics is only for natural geniuses: a subject in which one must possess innate talent for and that improvement in is infeasible.

For a wide variety of reasons already outlined, we strongly believe that percentage-based prerequisites are a poor academic construction that the mathematics department has twisted into a substitute for an effective education. We do not have much more to say to this point beyond that which was said earlier, except for noting that we believe the Mathematics Department and not the Faculty of Science is the appropriate place to deal with the fallout of these combined policies.

Science One should cover proofs

It would be extremely convenient for mathematically-interested students in the Science One program (of which there are typically relatively many) to be able to take a proof-focused course in their first year. An approach to calculus more focused on applications is of course understandable for a program designed to expose students to a broad cross-section of the sciences: but this unfortunately rules out the possibility of Science One students ever taking MATH 120/121.

While we would like it if there were an option to take MATH 220/223 in the first year alongside Science One for interested students, our understanding is that this - and indeed, requiring interested Science One students to take additional courses at all - is unfortunately infeasible for a variety of reasons. However, as Science One students going into majors that typically have required first year courses not covered by their curriculum seem to handle it fine, and combined with that Science One students entering the honours program appear to do relatively well: we believe that Science One students will be fine.

We instead treat Science One similarly to transfer students above, in that they will be somewhat expected to catch up: to take MATH 220 either first year or over the summer, as

students entering the computer science program do with CPSC 110. We believe this to be reasonable. It should also be noted that this is not a regression but rather, a *lack* of change to the current curriculum for Science One students.

The Science Breadth requirement

Whether mathematics qualifies as a science is a topic of some debate. While students in mathematics often share interests with topics in the sciences: the study of pure mathematics does not benefit greatly from, for example, introductory environmental science or biology. The Science Breadth requirement is thus considered by many a counterproductive usage of electives slots and it is commonplace for students to do the absolute minimum to fulfill it. We believe it would be much more productive to have a "Breadth in Mathematics" requirement: but this would be an unpleasant constraint if in *addition* to a Breadth in Science. The Arts requirement, although often approached by students with the same kind of unfortunate attitude to do the minimum required, does at least frequently serve to introduce students to formal logic and foundations through courses offered by the Philosophy department. We are aware that several in the MATH department have advocated for the removal of or change to the Breadth requirement, and we appreciate it.

Mastery based assessments

Alternate grading schemes are infeasible to implement at the level of a department policy; academic freedom necessarily allows professors immense flexibility in their assessment structures. Still, a letter like this would be remiss if it didn't mention alternate grading schemes, most notably mastery based (also known as standards based) grading. Grades, in their current form, serve a patchwork of purposes, some of which directly conflict with one another. Most notably, grades serve as assessments of student ability (both internally and externally), a coarse form of feedback, and an incentive structure. The philosophy behind alternate grading schemes is that, "traditional" grading (a weighted average of components, usually with a very strong focus on an exam, with no opportunities for rewrites) fails all of these goals; it fails to incentivize the most helpful parts of learning, it fails to assess the most meaningful skills, and it fails as feedback.

There is an immense amount of published research showing that grades do not work as feedback. When student work is returned with both a grade (evaluative feedback) and written (descriptive) feedback, students overwhelmingly ignore the descriptive feedback. Brookhart's 2008 paper "*How to Give Effective Feedback to Your Students*" concludes, "the grade 'trumps' the comment" and "comments have the best chance of being read as descriptive if they are not accompanied by a grade." See also the litany of citations in Schinkse and Tannery's 2014 paper *Teaching More by Grading Less (or Differently)*. The stress created by grades mean that students often aim to succeed at the assessments, instead of learning the material - since grades have real effects on student finances and future prospects, there is a strong focus on cramming for tests, or memorizing instead of understanding content, which works in the short term, but leaves students stranded in upper year courses.

The last failure is described by the article *Mastery-Based Testing in Undergraduate Mathematics Courses* (Collins et al., 2019) far better than we could:

As teachers, we use assessment as an aid to determine student learning and achievement as well as communicate feedback to our students on their understanding of course concepts. Frequently, an A letter grade corresponds to exceptional performance and learning, whereas a C is average, and a B somewhere in between. What precisely is indicated when we average these letter grades over many assignments? Does an A signify exceptional competency on all learning goals or merely satisfactory competency on all learning goals? What does a C mean? Did the student attain some of the outcomes at a satisfactory level and others not at all? Did the student demonstrate partial understanding of all of the course concepts? When a grade is determined by a weighted average it could be either, or a mix of both. A final percentage grade of 70% could be obtained by earning a 7 out of 10 on all work, or 10 out of 10 on 70% of the work and zeros on the remaining 30% of the work.

The reason we mention these is that, as it stands right now, UBC has rigid, inflexible grading schemes, with little chance for redemption and no incentive to engage with feedback. This deeply reinforces the message that success or failure is binary, and innate. It does not matter if you can catch up, improve skills throughout the course, or if you struggled for reasons entirely unrelated to your mathematical ability; if you do poorly, there is a blemish on your final grade, and your future course prospects suffer. Further, the incentives provided by the exam-heavy grading structure means that students whose grades lag will often spend time cramming for exams, not deeply internalizing the content. The systemic, cultural issues above are underpinned by a deeply unfair and unsuccessful system of grading, which reinforces a static mindset over a growth mindset (something which is demonstrably bad for student learning -- see the citations of Schinkse and Tannery's paper). There appears to be no public acknowledgement by the department that this is an issue, nor any communicated plans to change it; even if there is work being done behind the scenes, the fact that students cannot see it is a deep disservice to the mathematical community.

In Summary

We consider the current state of the MATH degree to be fundamentally broken. For honours students, it sets punitively high prerequisites as a replacement for preparation, graduating few while offering only an equivalent education to other institutions. For majors students, it offers little rigor and few ventures into the world of mathematical proof, pushing students out the door without the bare minimum of a mathematics degree. The program as a whole sets all students up for failure, punishes students at the slightest slip, and offers no pathways for catch up or redemption. Degrees at other institutions - which we have not examined in depth here, but are fairly well aware of - do not share the same set of issues as the UBC mathematics curriculum, and we think that any mathematics student here would be significantly better served by such other curricula.

We have proposed the following changes to courses:

- ❖ MATH 100: Current prerequisites. Credit excluded with MATH 120.
 - MATH 101: Prerequisite: MATH 100/120. Credit excluded with MATH 121.

- ❖ MATH 120: Current prerequisites. Credit excluded with MATH 100.
 - Students can drop to MATH 100 at any time. *This must be in the syllabus.*
 - MATH 121: Prerequisite: MATH 120 *only*. Credit excluded with MATH 101.
- ❖ MATH 220: No prerequisites. First year course.
- ❖ MATH 223: No prerequisites. First year course. Credit excluded with MATH 221.
 - Students can drop to MATH 221 at any time. *This must be in the syllabus.*
- ❖ MATH 221: No prerequisites. Credit excluded with MATH 223. First year course.
 - MATH 310: Prerequisite: MATH 221. Credit excluded with MATH 223. Second year course.
- ❖ MATH 217: Prerequisite: MATH 101/121. Intended for MATH honours.
- ❖ MATH 226: Prerequisite: MATH 101/121. Intended for MATH majors.
 - MATH 227: Prerequisite: MATH 200/226. Intended for MATH majors.
- ❖ MATH 200: Prerequisite: MATH 101/121. Intended for students not in MATH.
 - MATH 317: Prerequisite: MATH 200/226. Intended for students not in MATH.
- ❖ MATH 320: Prerequisite: MATH 121, MATH 101 + 220, or MATH 101 + 223. No minimum grade. Second year course.
 - MATH 321: Prerequisite: MATH 320. No minimum grade. Second year course.
- ❖ MATH 322: Prerequisite: MATH 223, MATH 310, or MATH 221 + 220. No minimum grade. Second year course.
 - MATH 323: Prerequisite: MATH 322. No minimum grade. Second year course.
- ❖ All 300 and 400 level courses: no minimum percentage in any of their prerequisites.
- ❖ Course code changes to reflect the years they are intended to be taken.

In addition, we believe that an additional tutorial section for MATH 120/121/223 (perhaps taking up the additional lecture/week that MATH 120/121 currently have) would be extraordinarily beneficial to student understanding. We are aware departmental resources are limited, but of all the courses, the first year ones are the ones that need additional instructional support the absolute most. We have also provided feedback about certain specific ways in which the introductory math courses could facilitate a culture of inclusivity, though this feedback is nothing the mathematics department has not heard before from Dr. Piccolo and Dr. Coles.

We believe this proposal would significantly improve the mathematics degree. For honours students, these changes will let them access upper-year courses much earlier, without fear of being permanently locked out of course tracks of their interests for the rest of their degree from one or two bad days. For majors students, these changes will let them reasonably graduate with analysis, algebra, and possibly even topology under their belt, broadly thought of as the standard in any degree in mathematics. For all students, proper preparation and the removal of percentage-based prerequisites will significantly reduce stress while significantly increasing what they get out of their university degree. We believe these changes to be tightly linked, and think that only a partial implementation will not go very far.

We hope that the mathematics department takes our feedback seriously.

Signed,

- ❖ JJ (Major in Mathematics, Minor in Linguistics, President of the UMS)
- ❖ Morgan Arnold (Honours in Mathematics, President Emeritus of the UMS)
- ❖ Aryan Tiwari (Honours in Mathematics & Physics, VP Comms Emeritus of the UMS)
- ❖ Nicky Priebe (MSc. Mathematics)
- ❖ Jimmy Yang (Major in Mathematics)
- ❖ Julia Rees (Major in Mathematics)
- ❖ Leo Foord-Kelcey (Major in Computer Science, Minor in Mathematics)
- ❖ Audrey Lacey (Major in Mathematics)
- ❖ Christian Campbell (Major in Mathematics)
- ❖ Alessandro Adami (Major in Mathematics)
- ❖ Conor Brennan (Combined Major in Computer Science and Mathematics)
- ❖ Milo Piccini Noble (Combined Major in Computer Science and Mathematics)
- ❖ Chayce Hughes (Honours in Mathematics & Physics)
- ❖ Shreya Diwan (Major in Mathematics, Minor in French)
- ❖ Al Rahim Hossain (Major in Mathematics)
- ❖ Alex Macqueen (Honours in Philosophy, Major in Mathematics)
- ❖ ...
- ❖ Your Name (Honours/Major/Minor in Mathematics, any positions / awards if you want)

sign by switching to “Suggesting” in the upper right corner and adding a bullet point!
if you would like to sign anonymously, feel free, but we encourage putting your name!