

Encouraging Student Engagement in Lecture-based Mathematics Courses

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Summary

This workshop will focus on promoting student engagement through small changes within the traditional lecture-based model of an undergraduate mathematics class. The workshop focuses specifically on the language we use to introduce courses, to teach in the classroom, and to provide support to students. The workshop seeks to identify unhelpful trends in the language which is commonly used in the mathematics classroom and to offer alternatives which have been shown through research to cultivate a more positive learning environment (e.g., Slattery & Carlson, 2005; Mesa & Chang, 2010; Rattan, Good & Dweck, 2012).

The workshop begins by comparing the effect of using mathematical jargon versus accessible vocabulary when introducing a mathematical subject to new students. Next, the facilitator will define and identify monogloss versus heterogloss voice and discuss the impact each can have on classroom discourse. Finally, the workshop looks at the way in which we provide feedback to students. Even with the best intentions, the language used when providing feedback can actually result in demotivating students and lowering their expectation of success. Participants will consider examples of statements to avoid and construct a model for providing more effective feedback.

Many undergraduate students see math courses as a necessary evil they must “suffer through” and as such are disengaged from the material. This workshop aims to show that we can improve student motivation and achievement by using accessible language in the course syllabus, by employing linguistic techniques which promote student participation in the classroom, and by offering strategy-oriented feedback throughout the course. This workshop will apply these techniques to address four main areas of improvement in an undergraduate mathematics course (see Figure 1). Working from the first to the last day of class, small changes in language can be used to address the important questions found at each stage.

Keywords

language, motivation, feedback, lecture-based course, undergraduate mathematics

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Caroline Junkins, The University of Western Ontario

SUMMARY

This workshop will focus on promoting student engagement through small changes within the traditional lecture-based model of an undergraduate mathematics class. The workshop focuses specifically on the language we use to introduce courses, to teach in the classroom, and to provide support to students. The workshop seeks to identify unhelpful trends in the language which is commonly used in the mathematics classroom and to offer alternatives which have been shown through research to cultivate a more positive learning environment (e.g., Slattery & Carlson, 2005; Mesa & Chang, 2010; Rattan, Good & Dweck, 2012).

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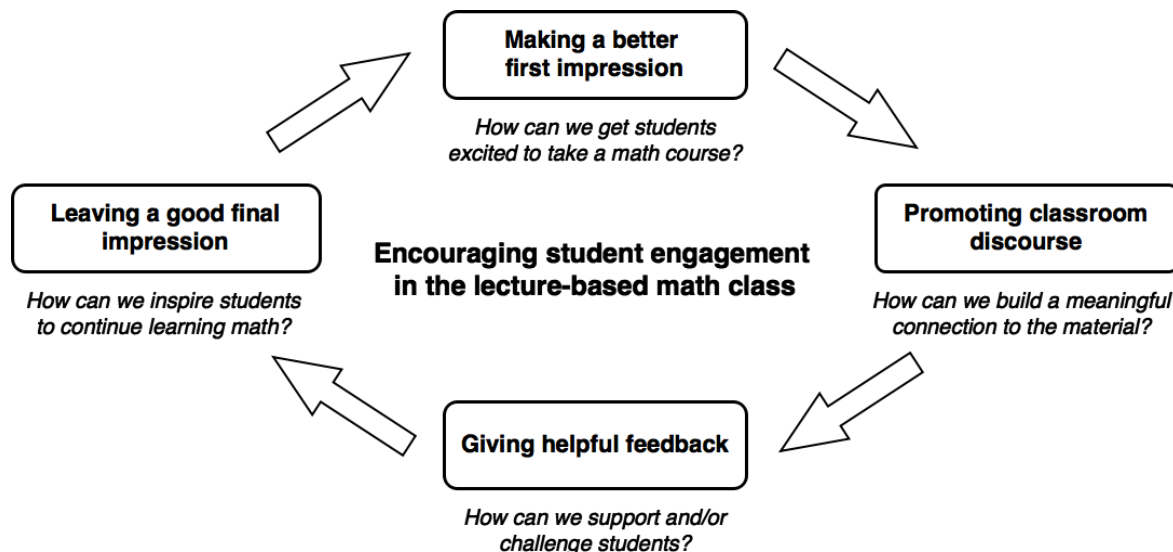


Figure 1: How can we improve the student experience in an undergraduate mathematics class?

KEYWORDS: language, motivation, feedback, lecture-based course, undergraduate mathematics

LEARNING OUTCOMES

By the end of this workshop, participants will be able to:

- Effectively convey the learning outcomes of a mathematics course to undergraduate students by designing a course overview using accessible language.
- Recognize monogloss/heterogloss voice and assess the impact each can have on classroom engagement through discussion.
- Evaluate the effectiveness of common feedback techniques used in mathematics instruction and develop a model for providing effective strategy-oriented feedback to students.

REFERENCE SUMMARIES

Slattery, J.M., & Carlson, J.F. (2005). Preparing an effective syllabus: Current best practices. *College Teaching*, 53 (4), 159-164.

In this paper, Slattery and Carlson describe how the course syllabus is an important tool for teaching and learning. An effective syllabus “communicates the overall pattern of the course so a course does not feel like disjointed assignments and activities, but instead an organized and meaningful journey” (Slattery & Carlson, 2005, p. 159). The authors suggest that students reading a friendly or encouraging syllabus are more likely to see themselves as active participants in the learning process, while students reading a condescending or confrontational syllabus may be discouraged and have lower expectations of their success in the course. The main contributions of the paper to this workshop are the suggestions for the Course Description and Course Goals sections of the syllabus, which are considered together in the Course Overview component of the workshop. While Course Description and Goals are often used to reiterate the course catalog description, they can be more effectively used to provide a sketch of how instructors approach material and how they in turn expect the student to interact with the material.

Mesa, V., & Chang, P. (2010). The language of engagement in two highly interactive undergraduate mathematics classrooms. *Linguistics and Education*, 21 (2), 83-100.

In this case study, Mesa and Chang consider the way language is used by instructors to engage students in two undergraduate mathematics classes. This use of language is illustrated via the interplay of two major discursive voices, monogloss and heterogloss. Monogloss seeks not to engage, but only to provide facts or “bare assertions”. In general, monoglossic voice/text sounds impersonal or report-like. By comparison, heteroglossic voice/text grounds a proposition in the personal subjectivity of the speaker/writer, leaving room for negotiation or re-examination, thus engaging the listener/reader at different levels. Since the authors pull examples of these discursive voices from a first-year math class, they are a perfect fit for introducing the above terminology to workshop participants.

Focusing on heteroglossia, the authors describe how instructors use language to expand or contract an argument by either making room for alternative positions, or by aligning the listener/reader with a particular point of view. They illustrate how heteroglossic discourse can be used not only to provide or clarify information, but also to seek explanations and suggestions from the students. The authors propose that by entertaining thoughts or ideas from students we can mitigate the authoritarian voice which is a typical feature of mathematics and which may exclude some groups of students from participating in the mathematical discourse. This workshop presents the findings of this paper as a model for creating a more interactive classroom through our choice of language.

Rattan, A., Good, C., & Dweck, C.S. (2012). "It's ok — Not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students, *Journal of Experimental Social Psychology*, 48 (3), 731-737.

The authors begin by describing implicit theories of intelligence as they relate to beliefs about mathematical ability. Most people view math intelligence as something which is either fixed (entity theory) or malleable (incremental theory). In Studies 1-3 of the article, the authors show that instructors holding an entity theory are more likely to judge a student as low-ability based on a single test score. In Studies 2-3 they go on to show that when an instructor views a student as low-ability, they are more likely to offer comforting or "kind" feedback that is unlikely to promote engagement with the field. In Study 4, the authors show that students receiving comfort-oriented feedback not only perceive the instructor's entity theory and low expectations, but also report lowered motivation and lower expectations for themselves. Since this workshop is concerned with language, we focus on the point that even if our feedback is given with the best intentions, the way we express support can ultimately backfire. By avoiding comforting statements we can actually help a struggling student succeed.

For Study 4, the authors also compared strategy-oriented feedback (providing concrete suggestions along with statements of caring) to control feedback (statements of caring only). This comparison yielded a significant difference, suggesting that strategy-oriented feedback "leads to more positive perceptions of a professor's expectations and investment" (Rattan, Good & Dweck 2012, p. 735). The authors also note that caring statements alone did not lead to the most negative outcomes; these were only seen with the addition of comfort-oriented feedback. In the workshop, participants will learn that effective feedback is positive and caring but should also communicate concrete strategies for improvement to the student. Examples of helpful/hurtful feedback described in this paper will be presented to workshop participants during the "Effective Feedback" activity.

Pokay, P., & Blumenfeld, P.C. (1990). Predicting achievement early and late in the semester: The role of motivation and use of learning strategies, *Journal of Educational Psychology*, 82 (1), 45-50.

This paper examines the relationships between motivation, use of learning strategies, and student achievement throughout a high school geometry course (a topic that today is typically reserved for undergraduate studies). The authors analyze data from questionnaires completed by students early and late in the semester. These questionnaires are designed to measure motivational factors (math self-concept, expectancies for success, and perceived value of the subject matter), learning strategies (cognitive, metacognitive, and effort management), and achievement (early and late test grades). The authors found a significant correlation between all three motivational factors throughout the semester and a relationship between these factors (excluding early value) and achievement. Perceived value was significantly correlated with all types of strategies used throughout the semester, while self-concept and expectancies were correlated with the use of effort management strategies only. Effort management strategies were in turn related to both early and late achievement, suggesting that while perceived value does not directly predict achievement, it may act through its effect on strategy use.

The findings of this paper ground the rationale for this workshop, which is communicated to participants by presenting each topic as a strategy to be used for motivating students at a specific stage of their first-year mathematics course (see Figure 1). If an instructor's main goal is to help their students succeed, then cultivating self-concept of ability and perceived value of the subject matter are essential to accomplishing this goal. Taking steps towards increasing student engagement in first-year courses can

yield a positive effect on these motivational factors. This effect can be augmented by providing students with feedback containing effort management strategies.

CONTENT AND ORGANIZATION

Duration (MIN)	Subject	Activity	Purpose
10	Introduction	<p>Provide a brief overview of the need for encouraging student engagement in first-year math courses and the obstacles we face in doing so.</p> <p>Present the proposed cycle (Figure 1) for addressing this need within the standard lecture-based model.</p>	<p>Articulate the overall theme and outcomes of the workshop.</p> <p>Stimulate consideration of the four questions proposed by the cycle and how we plan to address them.</p>
30	Syllabus Design (Small Group Role-play and Brainstorm)	<p>After a short introduction, break participants into groups of 4-6 people.</p> <p>Part A: Provide each group with a case study, template, and sample response guide (Appendix A1-3). Ask them to identify segments of the course overview containing language which is inaccessible or unhelpful to the student from the profile.</p> <p>Part B: Ask the group to brainstorm “translations” for (or additions to) the identified sections to create useful information for the student. One member of the group is asked to fill in the template with suggestions from the group. These should be collected, compiled, and returned with feedback after the workshop.</p>	<p>Use small groups to foster collaboration and community in the workshop.</p> <p>Encourage participants to put themselves in their students' shoes and explore how language that is commonplace to instructors may appear from their perspective.</p> <p>Persuade participants to set aside traditional practices and to use the course syllabus as a tool for cultivating a good first impression.</p> <p>Assess participants' learning and provide constructive feedback on their suggestions. Distribute results of all groups to highlight the range of possible outcomes for the activity.</p>
20	Language Analysis (Presentation and Group Discussion)	<p>Define monogloss/heterogloss voice and provide examples of each from an undergraduate math class (c.f. Mesa & Chang, 2010). A sample handout can be found in Appendix B.</p>	<p>Provide participants with a formal linguistic framework for interpreting the language we use when teaching.</p> <p>Examine how overuse of</p>

		Discuss ways in which the linguistic choices of instructors can help or hinder classroom discourse, and in turn influence students' performance. Discussion questions are provided in Appendix B.	monogloss voice can limit student participation, while appropriate use of heterogloss voice can be used to promote/steer classroom discourse. Explore how we can balance these voices in lecture while still covering required material in a reasonable time.
25	Effective Feedback (Dotmocracy)	<p>Part A: Write examples of feedback (see Appendix C) on large sheets of paper and place around the room. Provide participants with a sheet of sticky dots, and ask them to affix one or more dots to any example they would consider helpful to students (more dots = more helpful).</p> <p>Part B: Present the findings of Rattan et al. (2012) on how comfort-oriented feedback can have a negative impact on student motivation while strategy-oriented feedback can promote greater effort and engagement.</p> <p>Ask participants how the information from Rattan et al. (2012) would have affected their votes. Do they agree with the authors?</p>	<p>Gauge participants' initial beliefs on how best to provide support and feedback to students.</p> <p>Analyze the difference between our intentions when expressing support to a student and the reality of how such support can affect their motivation and performance.</p> <p>Provide examples of statements of support that communicate high standards and offer concrete strategies for improvement, along with statements of caring or statements offering comfort for perceived low ability.</p> <p>Have participants reflect on whether their personal beliefs and practices align with the ideas presented in this section of the workshop.</p>
5	Conclusion	Distribute final handout (Appendix D). Summarize the main points of the workshop and how the tools we've presented can be used to address all four parts of the cycle.	Direct participants towards available resources. Encourage them to incorporate the ideas and tools presented in this workshop into their current or future teaching.
Total Time: 90 minutes			

PRESENTATION STRATEGIES

By encouraging students to engage with mathematics in a positive way in their first-year courses, we can create a more interactive learning environment in our classrooms and form better relationships with our students. The skills discussed in this workshop are also not limited to teaching. By adjusting our language to communicate mathematics more effectively, we can also improve the clarity of grant proposals or job applications and become more engaging speakers in a conference or seminar setting.

This workshop is designed to take place in a classroom equipped with a data projector. Ideally, participants should be seated at tables of 4-6 to facilitate group work for the Syllabus Design activity. Coloured pens or highlighters may be also be useful for this activity. Paper handouts and sheets of sticky dots should be distributed to participants as needed during the workshop.

Goal 1: Making a better first impression (Syllabus Design Activity)

Many students enrolling in a first-year mathematics course are doing so simply because the course is either explicitly required for their program, or is one among a group of courses from which they may choose. These students may view mathematics as a collection of arbitrary laws and formulae with no purpose and limited applications to real situations. With these students, we are already starting off on the wrong foot through no fault of our own. The course syllabus offers us a tool for mitigating these factors and creating a more positive view of the course itself.

The main goal of this activity is to evaluate and improve syllabi for undergraduate mathematics courses. The secondary purpose of this activity is to have participants begin to think about the language we use and the impact it can have on student motivation (positive and negative). This will help prepare participants for the next module of the workshop, where we dive more deeply into language theory and develop a framework for analyzing the language we use in the classroom. This activity will work best with groups of 4-6. Handouts should be provided to participants and can be found in Appendix A. Results from each group should be collected by the facilitator and provided to all participants (preferably online) after the workshop, along with comments and feedback. Participants should then be encouraged to refer back to these examples when designing their own course syllabi in the future.

Goal 2: Cultivating classroom discourse (Language Analysis Presentation/Discussion)

Our words are never neutral, not even in a mathematics lecture. While we tend to perceive lectures as objective transmissions of information from the instructor to the student, the choice of language used when conveying this information can affect the agency of the students. Language can be used to encourage students to explain or justify their thinking, to examine arguments and counterarguments, and to make connections and conjectures. On the other hand, language can also be used to shut down discussion, limit avenues of thought or investigation, and remove room for negotiation. By constructing a framework for analyzing our own language, we can illustrate the impact it has on the dialog in our classroom.

In this section of the workshop we introduce the terminology required to produce a framework for analyzing the language we use in class. As this terminology will be new to participants, it is important to first provide definitions and clear examples. Appendix B contains examples of visuals that may be helpful for participants, either as handouts or presentation slides. Also included in Appendix B is a list of suggested questions which can be used to prompt group discussion.

Goal 3: Giving helpful feedback (Effective Feedback Activity)

One view of mathematical intelligence is that it is a fixed attribute, which is dictated by genetics and unchangeable. Holding this viewpoint can lead to a self-fulfilling prophecy, since a student who believes him or herself to be “just bad at math” will have decreased motivation, as well as decreased learning and achievement outcomes. Such a student is more likely to draw negative conclusions about his or her ability from setbacks, and to give up more easily when faced with difficulty (Rattan et al., 2012). The feedback we provide as instructors can reduce or increase this effect; by paying careful attention to the language we use, we can ensure that our good intentions translate into helpful support. Statements of support used for the Dotmocracy portion of this activity should be presented to participants without indication of their classification or helpfulness. After the workshop, however, these statements can be categorized under the headings of Statements of Caring, Comfort-oriented statements, and Strategy-oriented statements and made available to participants (preferably online) for reference.

Goal 4: Leaving a good final impression

“How do we inspire students to keep learning math?” While this question is not addressed directly in the activities of the workshop, leaving a good final impression can be thought of as the natural product of accomplishing the other three goals. If students start out their first-year math class on a positive note, engage with the material on a meaningful level, and receive constructive feedback from their instructor, they are more likely to have a favourable view of mathematics in general, and to see themselves as creators rather than just calculators.

APPENDIX A1

Syllabus Design Activity Handout, Part A - Cases

Case ONE

Step 1.

Read the following description of a first-year course offered by the Department of Mathematics as it appears in the academic calendar.

Course Title: Introductory Calculus

Description: Introduction to differential calculus including limits, continuity, definition of derivative, rules for differentiation, implicit differentiation, velocity, acceleration, related rates, maxima and minima, exponential functions, logarithmic functions, differentiation of exponential and logarithmic functions, curve sketching.

Prerequisites: At least one Grade 11 math course at the university/college-stream level.

Step 2.

Consider the following (fictional) student who intends to enrol in this course.

Anthony is a 24 year-old Canadian student enrolled in the Bachelor of Science program with intent to major in Biochemistry. After graduating high school and taking a certificate program at community college, Anthony worked as a lab technician for a pharmaceutical company. He did not feel challenged by this work and believes that upgrading his education will open up better job opportunities in his field. Anthony has not used calculus or other advanced mathematics since high school, 6 years ago.

Step 3.

Identify any language which may be inaccessible, irrelevant, or otherwise unhelpful to Anthony in the following excerpt from the “Course Overview” section of the course syllabus.

“Limits, continuity, definition of derivative, power rule, product rule, quotient rule, chain rule, higher order derivatives, velocity, acceleration, implicit differentiation, related rates, definition and properties of exponential and logarithmic functions, differentiation of exponential and logarithmic functions, relative/absolute maxima and minima, concavity, curve sketching, optimization.”

Case TWO

Step 1.

Read the following description of a first-year course offered by the Department of Mathematics as it appears in the academic calendar.

Course Title: Methods of Finite Mathematics

Description: Permutations and combinations; probability theory. This course is intended primarily for students in the Social Sciences, but may meet minimum requirements for some Science modules.

Prerequisites: At least one Grade 12 math course at the university-stream level (or equivalent).

Step 2.

Consider the following (fictional) student who intends to enrol in this course.

Belinda is a 17 year-old Canadian student enrolled in the Bachelor of Management and Organizational Studies program with intent to specialize in Human Resources Management. Belinda entered university immediately after graduating high school with an overall average of 90%. While Belinda is a strong student, she has struggled with mathematics and has taken the minimum number of secondary school math courses for admission into the Bachelor of Management and Organizational Studies program (Grade 12 Advanced Functions and Data Management). She has enrolled in Math 1228 due to its reputation of being the “easiest” way to fulfil her degree requirement.

Step 3.

Identify any language which may be inaccessible, irrelevant, or otherwise unhelpful to Belinda in the following excerpt from the “Course Overview” section of the course syllabus.

“Topics covered include techniques of counting, probability, discrete and continuous random variables. Students will be required to demonstrate an understanding of these concepts and an ability to apply them in solving a variety of problems.”

Case THREE

Step 1.

Read the following description of a first-year course offered by the Department of Mathematics as it appears in the academic calendar.

Course Title: Calculus I

Description: Review of limits and derivatives of exponential, logarithmic and rational functions. Trigonometric functions and their inverses. The derivatives of the trig functions and their inverses. L'Hospital's rules. The definite integral. Fundamental theorem of Calculus. Simple substitution. Applications including areas of regions and volumes of solids of revolution.

Prerequisites: Grade 12 “Calculus and Vectors” or Introductory Calculus

Step 2.

Consider the following (fictional) student who intends to enrol in this course.

Chun is a 19 year-old international ESL student enrolled in the Bachelor of Science program, undecided on her intended major. Chun completed secondary school in China and is interested in pursuing a degree in the sciences. She came to university with a history of high academic achievement but struggles with the fast-paced speech used in most lectures. Chun is not confident in her English conversational skills and prefers to ask questions of her peers rather than seek help from the instructor or TA. She is not particularly invested in learning calculus, but understands why it is necessary for her program.

Step 3.

Identify any language which may be inaccessible, irrelevant, or otherwise unhelpful to Chun in the following excerpt from the “Course Overview” section of the course syllabus.

“Review of limits and derivatives of exponential, logarithmic and rational functions. Trigonometric functions and their inverses. The derivatives of the trig functions and their inverses. L'Hospital's rules. The definite integral. Fundamental Theorem of Calculus. Simple substitution. Applications of integration, including areas of regions and volumes of solids of revolution.”

Case FOUR

Step 1.

Read the following description of a first-year course offered by the Department of Mathematics as it appears in the academic calendar.

Course Title: Linear Algebra I

Description: Properties and applications of vectors; matrix algebra; solving systems of linear equations; determinants; vector spaces; orthogonality; eigenvalues and eigenvectors.

Prerequisites: Grade 12 “Calculus and Vectors” or any 1st year calculus/linear algebra course (can be taken as co-requisite)

Step 2.

Consider the following (fictional) student who intends to enrol in this course.

Daniela is a 20 year-old international student enrolled in the Bachelor of Science program with intent to major in Mathematics.

Originally from Brazil, Daniela came to Western to pursue a degree in Software Engineering. After experiencing the Engineering common first year program, however, she made the decision that a mathematics program might better align with her interests. Daniela comes with a strong foundation in mathematics and has realized she prefers theory over applications.

Step 3.

Identify any language which may be inaccessible, irrelevant, or otherwise unhelpful to Daniela in the following excerpt from the “Course Overview” section of the course syllabus.

“Properties and applications of vectors; matrix algebra; solving systems of linear equations; determinants; vector spaces; independence; orthogonality; eigenvalues and eigenvectors.”

Case FIVE

Step 1.

Read the following description of a first-year course offered by the Department of Mathematics as it appears in the academic calendar.

Course Title: Calculus I for the Mathematical Sciences

Description: An enriched version of Calculus 1000A/B. Basic set theory and an introduction to mathematical rigour. The precise definition of limit. Derivatives of exponential, logarithmic, rational trigonometric functions. L'Hospital's rule. The definite integral. Fundamental theorem of Calculus. Integration by substitution. Applications.

Prerequisites: Grade 12 “Calculus and Vectors” or Introductory Calculus

Step 2.

Consider the following (fictional) student who intends to enrol in this course.

Elliot is an 18 year-old Canadian student on the path towards enrolling in the Bachelor of Medical Sciences program with intent to pursue medical school. Elliot has dreamed of being a doctor since he was

young and has worked hard in secondary school to graduate with a very high average. While CALC 1301 is the standard requirement for his program of study, Elliot has chosen to enrol in CALC 1501 instead. He is curious to explore math at a deeper, more rigorous level and also believes that having a "harder" course on his transcript may help his future medical school application.

Step 3.

Identify any language which may be inaccessible, irrelevant, or otherwise unhelpful to Elliot in the following excerpt from the "Course Overview" section of the course syllabus.

"Students who intend to pursue a degree in Actuarial Science, Applied Mathematics, Astronomy, Mathematics, Physics, or Statistics should take this course. Topics covered in this course include techniques of integration; the Mean Value theorem and its consequences; sequences and series, Taylor series with applications; parametric and polar curves with applications; first order linear and separable differential equations with applications."

APPENDIX A2

Syllabus Design Activity Handout, Part B - Question Template

Use the following questions as a guide to create useful information for the student.

- Course Title: _____ (Insert course title from Case X)
- Description: _____ (Insert description from Case X)
- Prerequisites: _____ (Insert prerequisites from Case X)

WHO is this course FOR?

What will I SEE in this course?

What will I DO in this course ?

What is EXPECTED of me if I take this course?

APPENDIX A3

Syllabus Design Activity Handout, Part B - Sample Response Guide for Facilitators/Participants

The course syllabus should be used as a complement to, not a copy of, the description found in the academic calendar. As suggested by Slattery & Carlson (2005)¹, the syllabus should be a place to clarify all important elements of the course, spark students' interest in the subject, and identify the key tasks and expectations. The course syllabus should NOT include language which can misguide, overwhelm, or intimidate the student. The answers provided in the example below can serve as examples for participants to consider when completing the activity.

Use the following questions as a guide to create useful information for the student.

- Course Title: Methods of Matrix Algebra
- Description: Matrix algebra including vectors and matrices, linear equations, determinants. This course is intended primarily for students in the Social Sciences, but may meet minimum requirements for some Science modules
- Prerequisites: At least one Grade 11 math course at the university-stream level

WHO is this course FOR?

This course is intended primarily for students in the Social Sciences who have completed at least one Grade 11 math course at the university-stream level. This course may meet minimum requirements for some Science modules, but is NOT sufficient as a prerequisite for second-year algebra courses.

What will I SEE in this course?

Topics covered in this course will help to sharpen your algebra skills and will include concepts such as vectors, equations of lines and planes, and systems of linear equations. We will also introduce matrix algebra, including matrix multiplication, inverses, and determinants.

What will I DO in this course ?

The course is designed to strengthen analytical thinking. Students will be asked/encouraged to find patterns, make conjectures, and judge the validity of given conjectures. Students will test their conjectures and provide counter examples to disprove invalid conjectures or give justifications for those they determine to be valid.

What is EXPECTED of me if I take this course?

Students are expected to attend all classes, demonstrate understanding of the course material through class participation, and complete all assigned homework. It is up to the student to seek out help when needed, from fellow students, the instructor, or the Math Help Centre.

¹ Slattery, J.M., & Carlson, J.F. (2005). Preparing an effective syllabus: Current best practices. *College Teaching*, 53 (4), 159-164.

APPENDIX B

Language Analysis Handout

We distinguish between two major discursive voices, as presented in Mesa & Chang (2010)¹.

Monogloss voice:

- Does not seek to engage the speaker/writer, only to provide facts or “bare assertions”
- Sounds impersonal, descriptive, or report-like
- *Is used to present the standardized forms of mathematical expression*

Heterogloss voice:

- Grounds a proposition in the personal subjectivity of the speaker/writer
- Leaves room for negotiation or re-examination
- Engages the listener/reader at different levels
- *Is used to convey the diverse expressions of mathematical meaning*

1. Invite students to consider possible strategies for solving the problem.

Computing an antiderivative for e^{-x^2} looks like it should be straightforward. It turns out, however, that this function has no elementary antiderivative at all. We call the function $f(x) = e^{-x^2}$ the Gaussian function.

2. Counter any such strategies by denying their chance of success.

3. Acknowledge the importance of this function.

Discussion Questions:

1. How can we use heterogloss statements/questions to assess students' understanding?
2. How can we use heterogloss statements/questions to encourage deeper thinking?
3. How might the effective use of heterogloss voice change when teaching mathematically-inclined students?
4. When would we need to include the monogloss voice in our lectures?
5. How can we include heterogloss statements/questions in lecture and still cover all the required material in time?

¹ Mesa, V., & Chang, P. (2010). The language of engagement in two highly interactive undergraduate mathematics classrooms. *Linguistics and Education*, 21 (2), 83-100.

APPENDIX C

Statements of Support - Effective Feedback Activity - Facilitator Notes

Instructions: Recreate and post the following statements at random around the room before the start of the workshop. Participants will engage with the statements during the “Effective Feedback” activity. Do NOT indicate the categories of the posted statements (i.e., caring, comfort or strategy). These categories will be discussed at the end of the activity.

The following statements have been chosen as realistic examples of well-intentioned feedback which fall within the three categories outlined by Rattan, Good & Dweck (2012)¹.

Statements of Caring

- Let's stay in contact to discuss how you are doing with the material.
- You are a talented student. I am glad you are taking my course.
- I can see that you are working hard to learn these concepts.
- I understand that you probably have a lot of work in your other courses right now.

Note: Statements of caring are a typical component of positive feedback and can help build the student-instructor relationship. However, this is contrary to the primary goal of feedback, which is to bridge the gap between current understanding and expected learning outcomes (Rattan, Good & Dweck, 2012).

Comfort-Oriented Statements

- Not everyone is a “math person”; your strengths just lie in other subjects.
- I'm going to give you some easier questions to work on instead so that you can get more comfortable with those skills.
- I won't call on you directly in class because I don't want to add extra pressure.
- Maybe you just need a little more time to finish the assignment; you can have until Monday.

Note: When students receive comfort-oriented feedback, they perceive their instructor as having lower expectations and investment. They feel significantly less encouraged and motivated, and expect to receive a lower final grade in the course (Rattan, Good & Dweck, 2012).

Strategy-Oriented Statements

- I want you to consider working with a tutor or with another student from class.
- I will make a point of calling on you more in class to ensure you are staying on track.
- I'm going to give you some more challenging questions so that you can learn to apply these skills to new situations.
- If you break down the assignment into manageable pieces and work on one each day, you will be able to complete it on time.

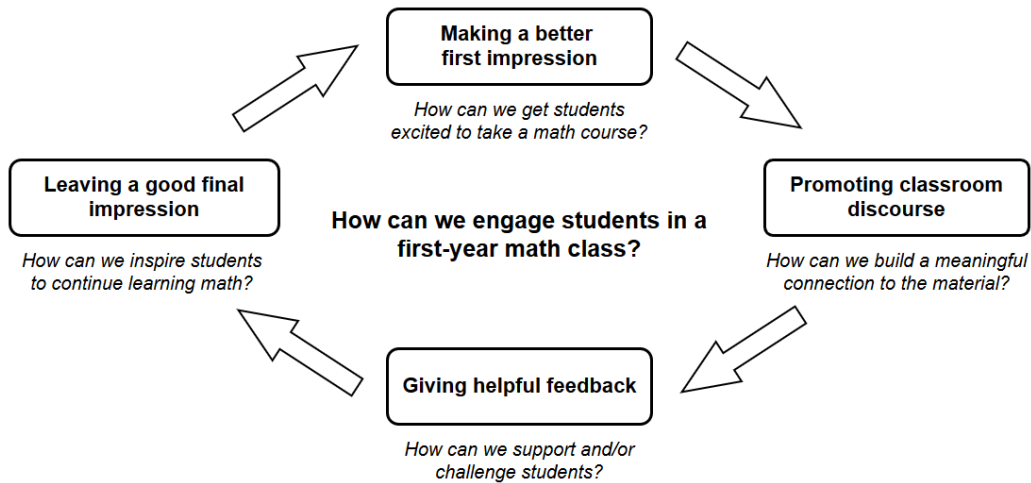
Note: Students who receive strategy-oriented feedback have more positive perceptions of their instructor's expectations and investment than those who receive only statements of caring (Rattan, Good & Dweck, 2012).

¹ Rattan, A., Good, C., & Dweck, C.S. (2012). “It's ok — Not everyone can be good at math”: Instructors with an entity theory comfort (and demotivate) students, *Journal of Experimental Social Psychology*, 48 (3), 731-737.

APPENDIX D
Workshop Takeaway Handout

Encouraging student engagement through small changes to the language we use in a lecture-based mathematics course

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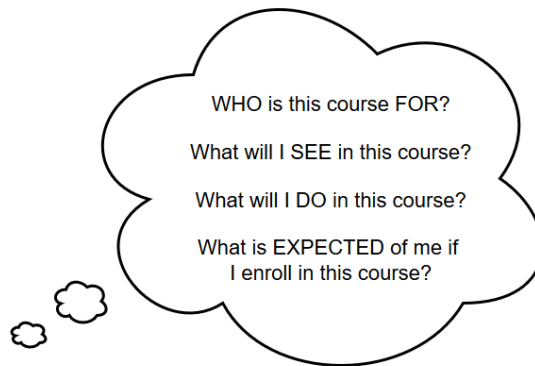
Many undergraduate students see math courses as a necessary evil they must “suffer through” and as such are disengaged from the material. We can improve student motivation and achievement by

1. using accessible language in the course syllabus
2. employing linguistic techniques which promote student participation in the classroom
3. offering strategy-oriented feedback throughout the course.

Leaving a good final impression can be thought of as the natural product of accomplishing the first three goals. If students engage meaningfully with their first-year courses, they are more likely to have a favourable view of mathematics in general, and to see themselves as creators rather than just calculators.

Step 1: Using the course syllabus to make a better first impression (reference: Slattery & Carlson, 2005)

Course Overview
<ul style="list-style-type: none"> • Acts as a complement to the description provided in the academic calendar • Clarifies the important elements of the course • Identifies the key tasks and expectations • Sparks students' interest in the subject • Uses language which is positive and at an accessible level for the potential student • Does NOT use language which can misguide, overwhelm, or intimidate



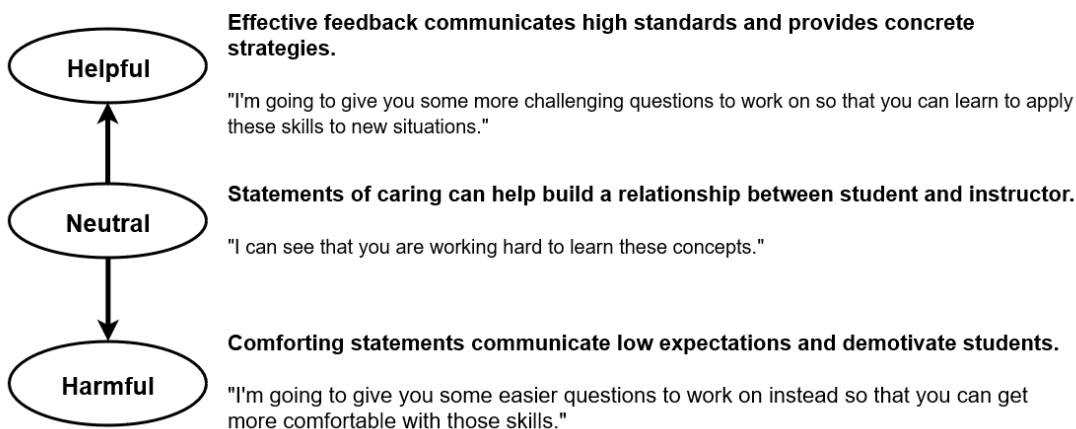
Step 2: Promoting classroom discourse through appropriate use of heterogloss voice
(reference: Mesa & Chang, 2010)

1. Invite students to consider possible strategies for solving the problem.

Computing an antiderivative for e^{-x^2} looks like it should be straightforward. It turns out, however, that this function has no elementary antiderivative at all. We call the function $f(x) = e^{-x^2}$ the Gaussian function.

2. Counter any such strategies by denying their chance of success.
3. Acknowledge the importance of this function.

Step 3: Giving strategy-oriented feedback to support and challenge students
(references: Pokay & Blumenfeld, 1990, Rattan, Good & Dweck, 2012)



Workshop References

Mesa, V., & Chang, P. (2010). The language of engagement in two highly interactive undergraduate mathematics classrooms, *Linguistics and Education*, 21 (2), 83-100.

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Slattery, J.M., & Carlson, J.F. (2005). Preparing an effective syllabus: Current best practices, *College Teaching*, 53 (4), 159-164.